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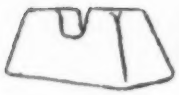

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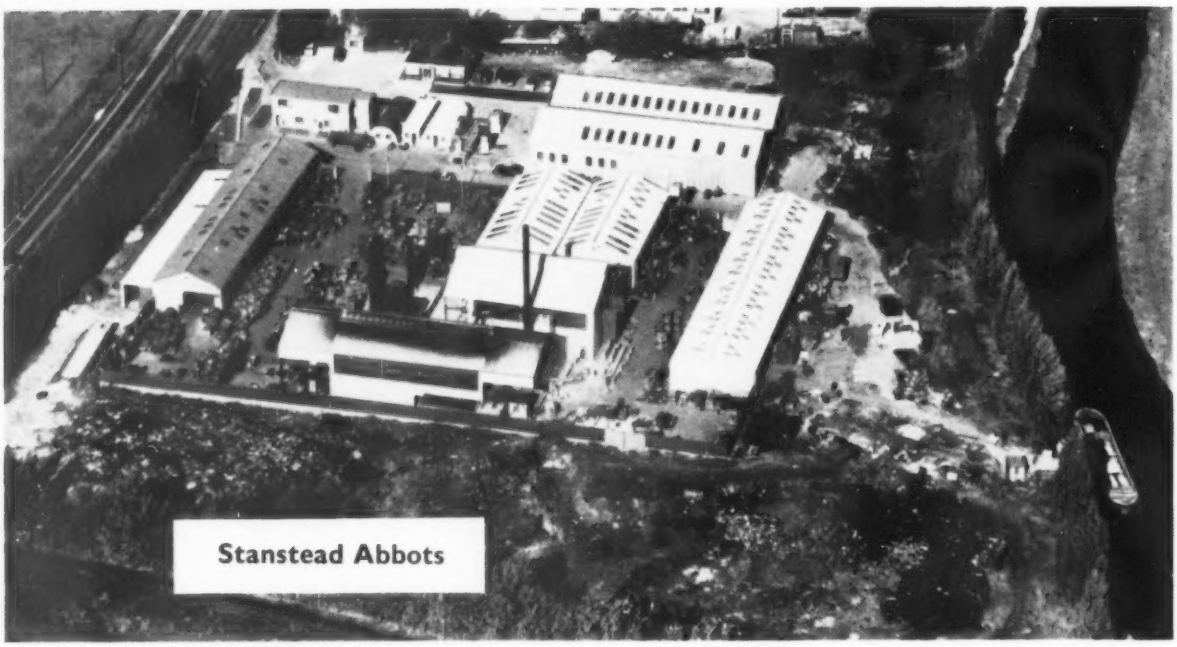

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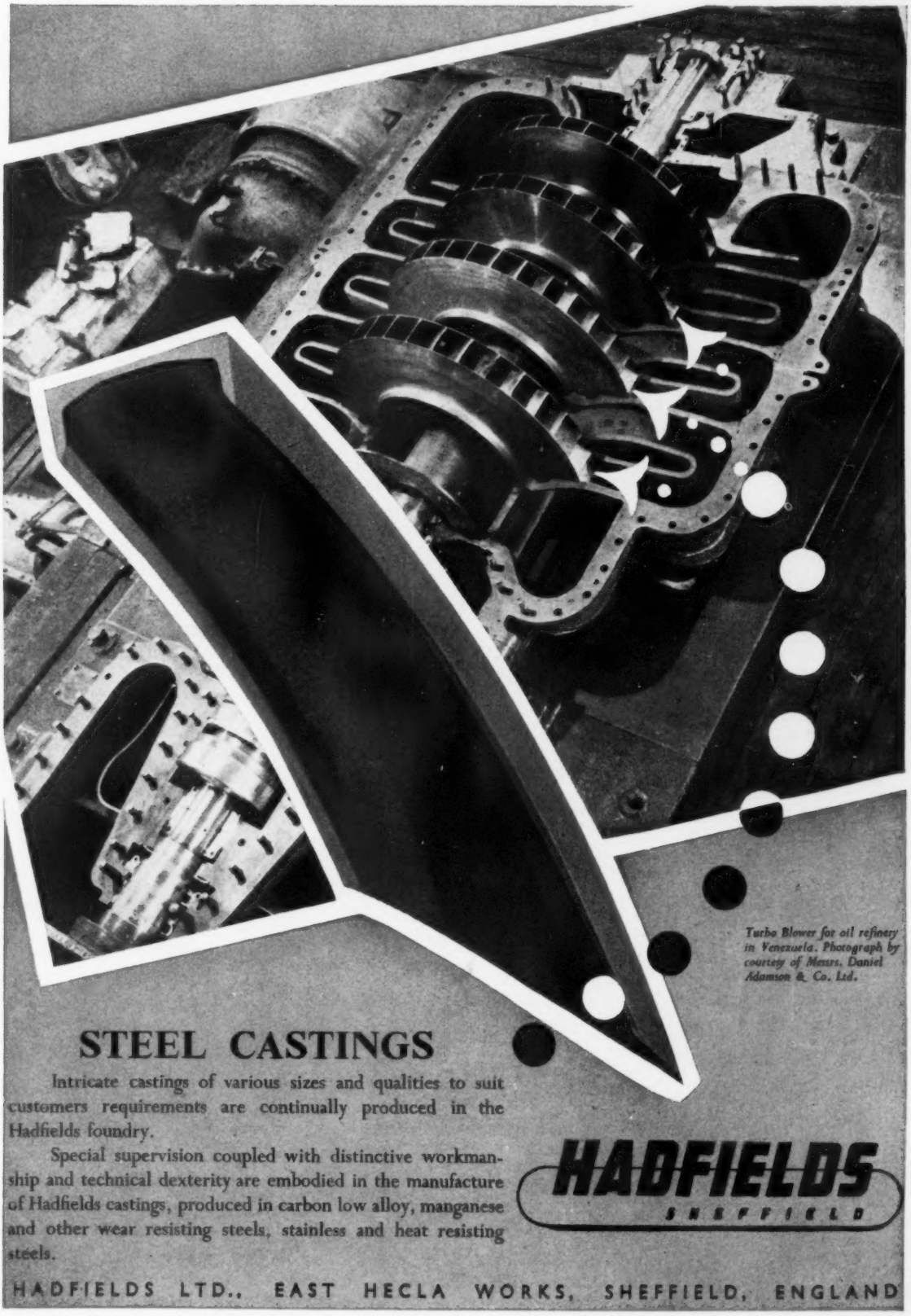

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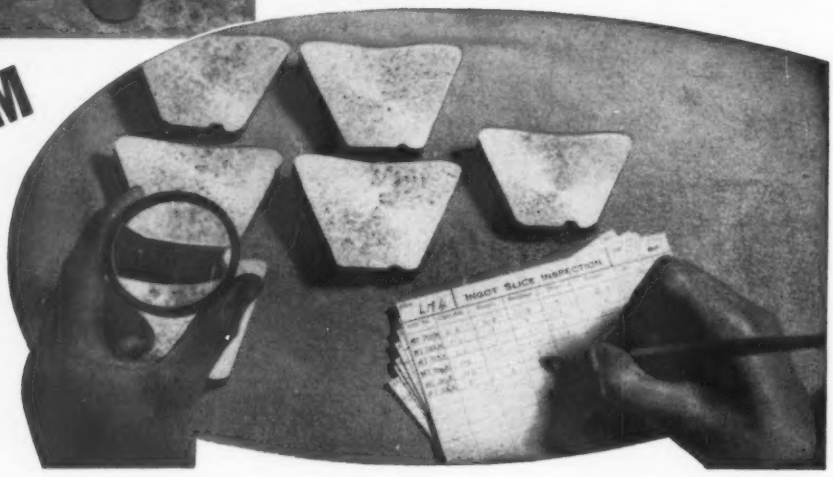

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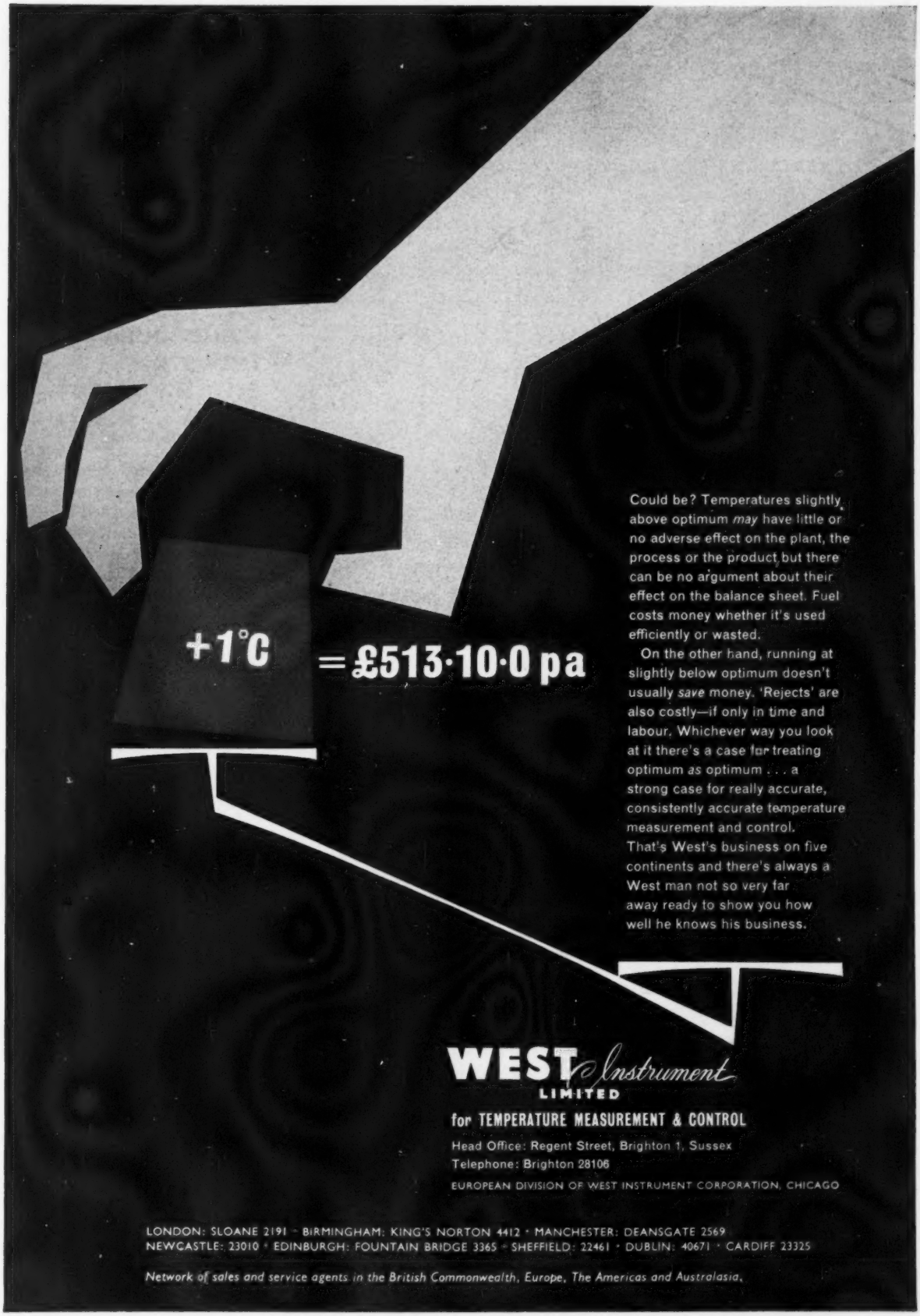

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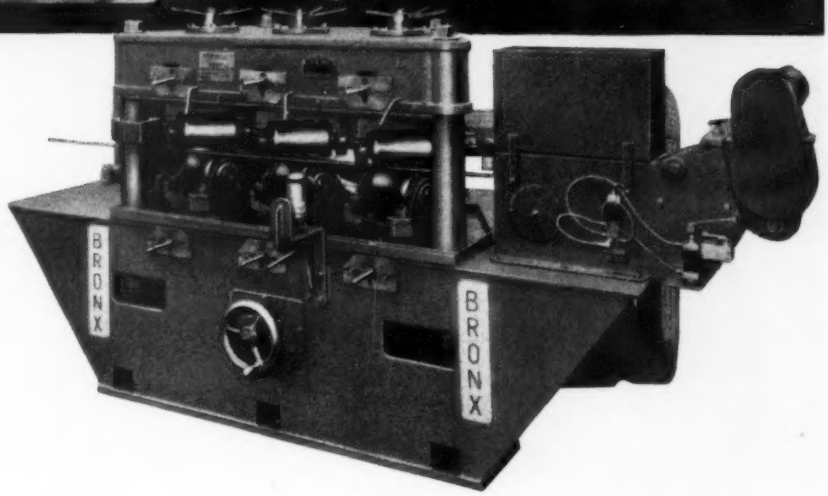

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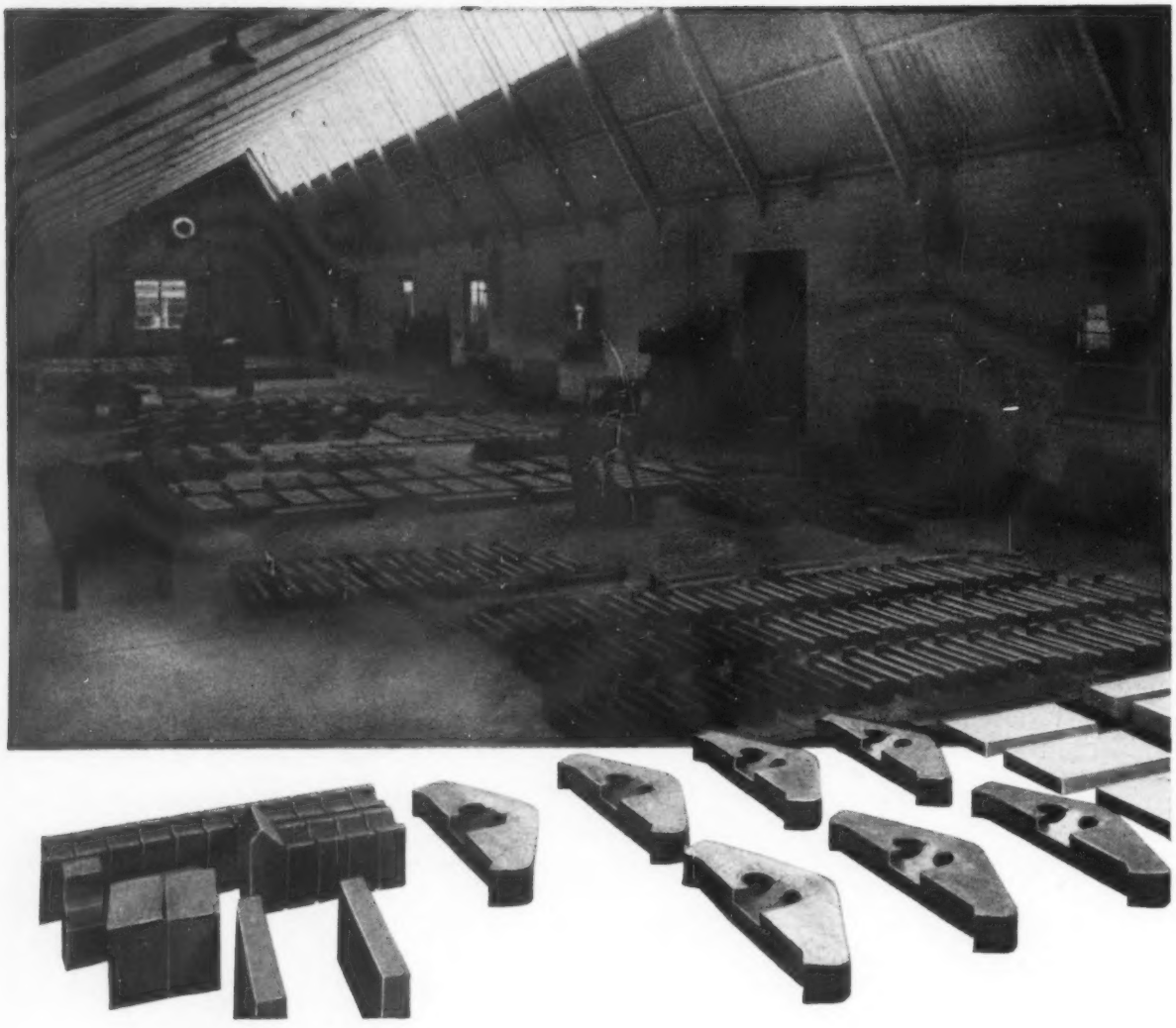

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A master builder—a master craft

And a meticulous craftsman. His standards are high, and so must be the quality of the materials under his hand. He chooses them with the same creative care he lavishes on the work itself. The choice of metals for quality die casting is equally critical; that is why the leading die casters put their confidence only in Mazak.

In some cases the existing procedure of a producer is accepted as the best practice of the art and is taken as a basis for the standard in question. Thus British Standard 1004 (Zinc Alloys for Die Casting) was based on the established practice of the Imperial Smelting Corporation in the production of Mazak.

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METAL INDUSTRY

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Helping the Buyer

IT is a sign that the sellers' market is well and truly over that two Trade Associations, in widely different fields, should deem it opportune to publish booklets setting out for the benefit of their customers the advantages to be gained by buying to British Standard Specifications.

Since the life of a plated article depends very largely on the type and thickness of plating applied, and the use to which the article is to be put, the booklet issued by the Metal Finishing Association rightly emphasizes that satisfactory work can only be guaranteed if the purchaser specifies the standards that he requires. Purchasers are reminded, however, that in specifying finish according to B.S. specification, it is necessary not only to give the specification number but also the grade of finish required, as these specifications cover a number of grades of different thicknesses suitable for different purposes. The importance of the design of an article to be plated is also stressed; improvements in design can often reduce plating costs and enhance the protective value of the coating. The value of careful selection of suitable basis metal to be treated, and where possible of a practical test of the metal prior to production, is pointed out in the sections dealing with anodizing and the polishing of stainless steel. The intended use of the article to be plated should also be made known to the plater when precious metals are to be deposited, so that the correct type of deposit and thickness may be established.

Covering copper and copper alloy castings to B.S.1400:1961, the guide issued by the Association of Bronze and Brass Founders deals first with the selection of alloys from this standard for particular purposes. In this section, recommendations are given for castings required for bearings, gears and wear resistance; high strength and resistance to fatigue; pressure tightness; resistance to corrosion; service at elevated temperatures. Again, it is emphasized that the co-operation of the founder should be sought whenever there is any doubt. Typical properties of the alloys are tabulated in the second section, while the advantages and limitations of six methods of casting are discussed in the third. A summary of chemical compositions and minimum mechanical properties of alloys to B.S. 1400:1961, and equivalent, similar and superseded specifications are also given. The final section covers the various alloy groups, their definitions, properties and uses.

In issuing these guides, the two Associations have shown that they are alive to the fact that in this competitive world the greater the co-operation between the producer and the purchaser the better it is for both sides. Both emphasize that pre-consultation on design is a vital factor in ensuring a more satisfactory product; both, too, stress the fact that the intended use of the product can influence the means to be adopted for its production. The A.B.B.F. has gone one step further than the M.F.A. by recently organizing a conference at which founders, designers, and purchasing officers discussed their mutual problems. The M.F.A. would do well to do likewise.

Spark Erosion Electrodes

By P. J. C. Gough B.A., A.M.I.E.E.
(*Solar Weld Languepin Limited*)

MATERIALS, MANUFACTURE AND APPLICATION TO DIE MAKING

COPPER, although not the cheapest of electrode materials for spark erosion operations, usually produces the best results and, therefore, finishing electrodes are almost always made from this material.

Of the various ways in which electrodes may be constructed, milling from bar or from rough castings is probably the easiest, provided that the electrode shape is of a kind that allows milling in the conventional manner rather than copy-milling. Phosphor-bronze, which is easier to cast than copper and gives very good results, has also been used.

If copy-milling or complex milling operations are necessary, it is often worth while attempting to form the cavity by making up a number of discrete electrodes which together form the entire cavity. Where copy-millers are available, however, it is frequently quite easy to construct a model of the cavity required, which can be used as the copy-form for producing a number of similar electrodes. It is recommended that the model for a copy-miller should be made in copper, or the electrode material, for not only is it easier to produce the male form of a cavity, but the form so produced can be used as a further model from which plaster moulds can be made and into which copper can be sprayed. Sprayed electrodes are cheaper than those machined from the solid, and consequently it is more economic to use these to produce most of the cavity, leaving the original model for use in the final finishing operation.

For deep, complicated cavities, a minimum of three to four electrodes is required. The sizes of these have to be adjusted by acid etching to suit the various erosion rates which are employed in forming the cavity. It is, of course, far better to spend more time in the region of high erosion rates, thus keeping to a minimum the amount of time spent producing the final finish. Wherever possible it is more expedient to remove as much metal as possible by conventional techniques before applying spark erosion, but naturally this is not the case when hardened steels are being used. In these instances it is usually better to "rough-out" the cavity first, harden, and then carry out the spark erosion operations. This eliminates the possibility of distortion and cracking which sometimes occur when a finished die is hardened.

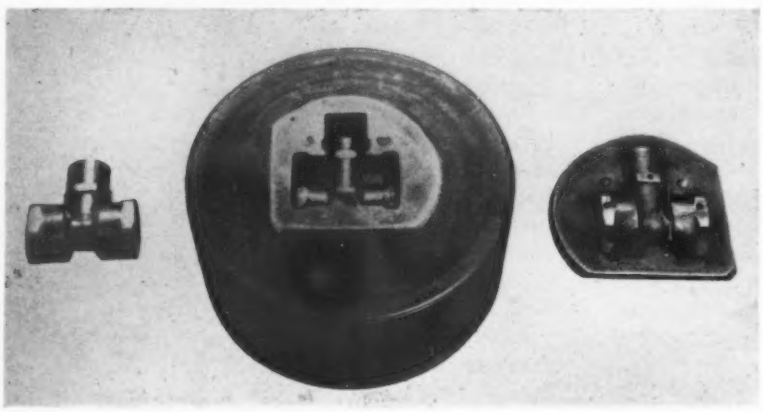
When the dimensional accuracy requirement is less than ±0·001 in., the maximum economy may be effected by the entire use of sprayed electrodes. If a steel mould is already in existence, spraying presents no problems, but, starting with a new die, one is faced with the problem of making a model of the cavity in wood, Perspex or metal, and from this model forming the plaster moulds into which the copper is sprayed. Whether produced from a plaster mould or a steel mould, sprayed copper electrodes lend themselves very easily to the insertion of copper or brass pipes, which can be used for dielectric fluid injection. Experience has shown that sprayed copper electrodes work very well, and the loss of electrode by erosion is no worse than that which applies with copper bar. The author's French colleagues have perfected the art of producing plaster moulds, and they are now in a position where they can produce from a single model a number of plaster moulds the dimensional accuracy and surface finish of which are as good as those of the original model.

Copper is sprayed into these moulds cyclically in batches; that is to say, seven or eight moulds are taken together and sprayed in cyclic sequence. To ensure that the temperature of the copper is kept low, a small amount is sprayed into each mould in turn so that by the time the cycle is complete the copper has cooled in readiness for the next cycle of spraying. The process is repeated until a sufficient thickness of copper has been built up in each mould—usually an overall thickness of 0·1 in. is enough.

Perhaps the most significant work yet undertaken by the author's company, which illustrates the way in which a large number of simple shape electrodes can be used, is the construction of a gravity die mould which was produced for an associated company for the main body of a hand-tool. From their experience, it is now obvious that dies made in Nimonic will last as much as three times as long as dies made in conventional tool steel, and it was therefore decided in this particular case to use Nimonic 80. It is significant to note here that this die was produced entirely by spark erosion, and over 60 electrodes were used in the construction of both halves. The total time taken to make these 60 electrodes (of comparatively easy shape) was 300 hr., this including the time taken to produce the jigs and fixtures to hold the electrodes. The total time taken to produce this die by conventional techniques has been established at 680 hr., whereas the time taken to produce a single die-set by spark erosion is 470 hr.

In the drop-forging field, of course,

Brass stamping die with component on left and electrode on right. This die was spark eroded in 4½ hr., by comparison with the normal production time of 11 hr.



The choice of electrode material for any particular spark erosion task is one for which almost everyone who is working with spark erosion today appears to have his own technique of solution. In the event, the choice must necessarily depend on the work which is to be undertaken, and economy is likely most frequently to be the first consideration. This article describes the use of copper, aluminium, copper-tungsten and copper-sprayed electrodes, and in one instance the use of Nimonic 80 as a die material. It is thus of interest not only as a description of a manufacturing technique but also because it shows some of the more unusual applications of non-ferrous metals

Electrode assembly and spark-eroded press tool for punching clutch linings. The erosion machining time is 10 hr., whereas the time required by orthodox methods is 22 hr.

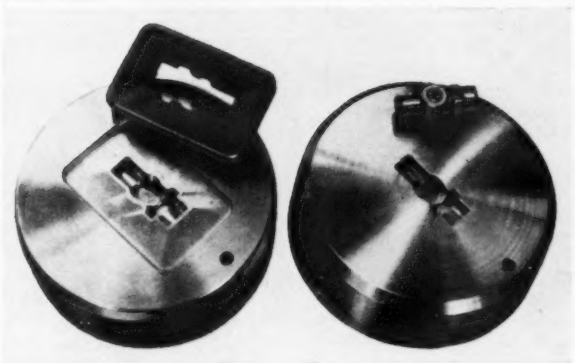
the need for repetitive dies is very much greater than applies with die-casting or with plastics moulding, and the question of electrodes is a relatively simple one. Existing steel dies can be used as patterns for sprayed electrodes, or electrodes can be forged and, provided care is taken during the forging of the electrodes, good cavities can be produced.

Electrode materials vary for different machines: in some cases, aluminium is quite a good material, and results are such that performances can be obtained which are equally as good as with copper. In other cases, cast iron can be used with very good effect. Copper-tungsten is reputed to produce the best effect when especially high precision is required, and it possesses the advantage of having a very low erosion rate. The price of copper-tungsten is about eight times that of copper.

The way in which electrodes are located and used is as important as their manufacture, and a great deal of success and, in particular, speed of operation depends on this. With most cavities, and especially re-entrant cavities, dielectric injection is essential. This must be used in such a way that clean dielectric fluid is injected into those regions of the spark gap where the products of erosion can accumulate. It is also worth noting (and this is not so well known) that it is occasionally of use to provide in the electrode a somewhat larger hole which will allow the escape of exhaust gases trapped in the spark gap.

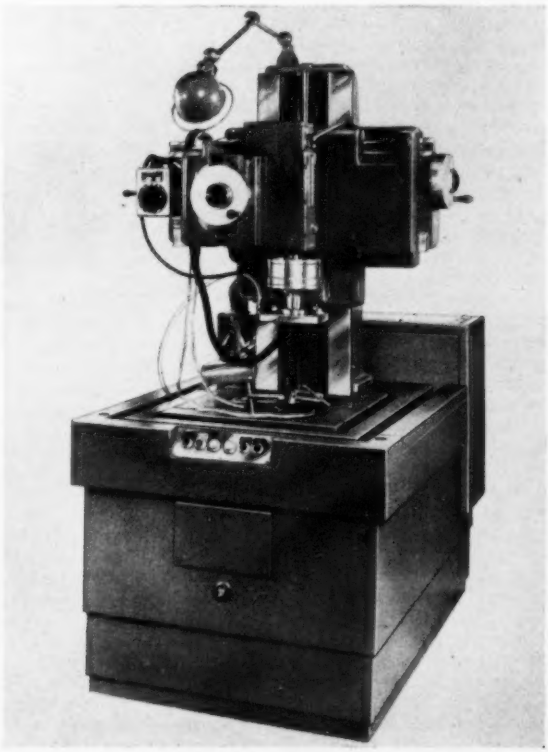
When dielectric injection and exhaust holes are used, a number of "pips" will be left in the cavity after the first

Machining the hexagonal bore of this cold drawing die takes 3½ hr. by spark erosion, as against 7 hr. by classical methods



Hot brass stamping die set together with electrodes for the cavity and the flash gate. Production time for an eroded die-set is 9 hr.: for a normally made set it is 20 hr.

The Seleromat B machine—a high-capacity, high-accuracy spark erosion equipment



electrode has been used. These "pips" may be removed by the next electrode by re-positioning the injection and exhaust holes. When a number of electrodes are used, this process can be repeated until the final stage is reached, when a "pip" of only 0·001 in. or 0·002 in. will remain. These final "pips" can be removed by grinding, or if they are in positions where grinding is not possible, small electrodes can be made which can be used to erode the "pips" to the final surface of the die.

A further method whereby the products of erosion may be assisted from the gap is by vibrating the electrode. This can be done by mounting the electrode carrier on a vibrator, the oscillations of which are restrained to the vertical plane. The effect of the oscillation is to produce a pumping action which, in turn, produces compressions and rarefactions in the spark gap: the resulting agitation pumps away the eroded debris, and is usually quite sufficient to remove the heaviest erosion products from the spark gap.

The surface finish which is obtained from an electrode depends entirely upon the surface finish of the electrode itself, and experience shows that if sufficient care is taken in preparing the electrode surface, finishes of the order of 0·5 microns can be obtained without difficulty.

Some tests have been conducted on the surface structure produced by "Seleromat" spark erosion machines, and findings confirm previous experiments which establish that a spark-eroded surface consists basically of four layers. Micro-hardness tests reveal the disparate variation from the parent metal to the outer skin, or surface. It is questionable whether the hard surface produced by spark erosion is a detriment since most workpieces are produced with the die in the hardened state and, therefore, any additional work which has to be done is normally done by grinding, and the change in hardness between the surface structure and the parent metal would consequently be very difficult to establish. French experience supports our own view that this surface hardness is in no way detrimental to the performance of a die, and in drop-forging work the extra hardness is possibly an advantage.

The stage is foreseen where non-consumable electrodes will allow a programme for the movement of the electrode over a surface in order to produce a cavity which is as complex as any which can be produced today, but which will not require the complexity of electrodes which, in certain difficult applications, is unavoidable at the present time.

Evaluating Sheet Fracture Toughness

HIGH-STRENGTH sheet materials in thicknesses down to about 40 mils have been satisfactorily tested by Charpy impact or slow bend using an edge-notch specimen similar to the standard V-notch Charpy specimen except for thickness. By comparing the Charpy results from other fracture tests, workers at Watertown Arsenal found that qualitative values could be expected for tough and moderately tough materials. In brittle materials, however, the Charpy results were found to be anomalously high due to elastic energy losses which, in the more extreme cases, overshadowed the total energy absorbed from all other sources combined.

Later work, reported in *Welding Journal Research Supplement*, showed that if Charpy sheet specimens were pre-cracked by a reverse bending technique or by fatigue, quantitative fracture toughness values were obtainable even in brittle materials. The results from pre-cracked Charpy sheet tests are expressed in terms of energy to propagate/unit of crack area (W/A). Expressed as in-lb/in^2, the W/A value is comparable with G_c and can be related to critical crack length at any desired stress level directly from the Griffith equation.

Excellent correlation was demonstrated between G_c and W/A in tests on a variety of high-strength aluminium sheet alloys where all tests were conducted in one laboratory and the Charpy tests were run slow in bend to eliminate the strain-rate variable. Qualitative correlation with edge-notched tensile tests conforming to the recommendations of the A.S.T.M. Committee on Fracture Testing was also observed, except in the tougher materials where the tensile test was insensitive to variations in fracture toughness.

The effect of strain rate on fracture toughness in high strength sheet materials has received comparatively little attention. This is because most of the tests in common usage require stress and sometimes critical-crack-length measurements which cannot easily be obtained under impact rates of loading. The Charpy tests, on the other hand, can be evaluated easily in either slow bend or impact; thus, the effect of impact loading on fracture toughness can be readily assessed.

Charpy slow bend and impact tests were conducted on a number of different steel, titanium and aluminium sheet materials. It was indicated that many high-strength sheet materials exhibit enhanced fracture toughness properties under impact loading conditions, but that there are some important exceptions. For example, the all-β B120VCA titanium alloy in the solution-treated condition exhibited much greater toughness in slow bend than in impact.

Several other materials showed better fracture toughness at slow rates of loading, but the effects were much less pronounced. The validity of these findings was corroborated by lateral expansion measurements in the aluminium materials and by fracture appearance in steel; i.e. the differences in energy to fracture between slow bend and impact were attended by corresponding differences in deformation and in the percentage of shear in the fracture surfaces.

Oxygen in Titanium

VARIOUS methods for the determination of oxygen in titanium metal and alloys have been investigated by U.S. Bureau of Mines chemists. The methods that have been found suitable for its determination in the range of 0·02 to 1·00 per cent oxygen are the dry crucible and platinum-flux vacuum fusion methods and the inert-gas fusion method. The work is described in the Bureau of Mines Report of Investigations No. 5834.

Selection of a method to use for the determination of oxygen in titanium would depend on the results wanted and the equipment available. From the standpoint of accuracy and speed for routine analysis of titanium metal the inert-gas fusion method and the modified platinum-flux technique of Covington are the most promising. From the standpoint of determining oxygen in titanium metal which contains less than 0·02 per cent oxygen the platinum-flux vacuum fusion method is preferred because of its precision in the lower ranges.

Obituary

Mr. A. C. W. Wood

IT is with regret that we record the death of Mr. A. C. W. Wood, a director of International Refining Co. Ltd. Mr. Wood served on the board of the company for 25 years and was a well-known figure in the non-ferrous metal trade. He had been honorary treasurer of the National Association of Non-Ferrous Scrap Metal Merchants for a number of years.

Metallurgy of Beryllium

REVIEW OF PROCEEDINGS AT THE INTERNATIONAL CONFERENCE ORGANIZED BY THE INSTITUTE OF METALS

WITH a high strength-to-weight ratio and a low neutron absorption cross-section, beryllium has a density of only 1·84, and its melting point is 1,292°C. These are extremely attractive properties for two particular fields of use: the first is as a canning material for fuel elements for nuclear reactors, and the second as a construction material in air/space vehicles. It was not surprising that the First International Conference on Beryllium, organized by the Institute of Metals, should attract 300 delegates from 13 different countries to listen to the presentation of 70 different Papers. The Conference was opened by the President of the Institute, Prof. H. O'Neill. In order to consider the large number of Papers, each session of the Conference was devoted to different subject matter, and in each session a Rapporteur summarized a number of closely related Papers. The main divisions were: (i) Mechanical and physical properties; (ii) Beryllium in reactors; (iii) Beryllium in aircraft; and (iv) Metal preparation and fabrication.

Beryllium is produced from its ores by two different routes. One of these is that employed in America, which results in powder of very fine grain size. The other route is an electrolytic one practised in France, the product from which is flake. Flake is contaminated with the other products of the extraction process and requires to be remelted and cast to ingots. Beryllium ingots generally suffer from coarse grain size and cracking, but are comparatively free from oxide when compared with the material from the American powder route. Powder beryllium may be pressed into shapes and subsequently worked by conventional rolling, extrusion and pressing processes; the ingots may also be formed by the same processes.

Physical Properties

The Rapporteur for the first session was Prof. J. G. Ball, of the Royal School of Mines, who considered three survey Papers. Prof. Ball illustrated the main problems in the technology by drawing a graph showing how the elongation of the metal varied with temperature: at room temperature beryllium has little ductility when tested in the conventional tensile test, but the elongation rises rapidly to a maximum at about 400°C., after this it falls to a minimum at about 600°C., and then generally rises as the temperature progresses towards the melting point. The Rapporteur said that the increase in elongation as the temperature rose above normal temperatures appeared to be fairly typical of the brittle/ductile transition found in many other metals: the minimum in the elongation at 600°C. appeared to be associated with grain boundary defects. When elongation in tensile testing was considered in more detail, cast beryllium had little if any elongation; extruded beryllium had a few per cent elongation in the direction of extrusion; rolled sheet had ductility in one or perhaps two directions, depending on the method of preparation, but very little within the thickness of the sheet. On the other hand, metal prepared by the powder route by sintering techniques had ductility in three directions. These differences pointed to a textural basis for the difference in properties.

Considering the high temperature properties at 600°C., one of the authors had shown that crystalline fracture occurred within this temperature range, but by heat-treatment the properties of beryllium could be considerably altered. Material quenched at 900°C. behaved quite differently from that slowly cooled. Elongation in the water-quenched material was less than that in metal which had been slowly cooled, suggesting that some kind of precipitation phenomenon had occurred, and that by slow cooling the precipitates were agglomerated into larger and less harmful masses.

Beryllium has an hexagonal close-packed structure, and slip is practically confined to the basal planes with a small amount on the prismatic planes. It was suggested that the precipitates mentioned above affected locking on the prismatic planes. The resolved shear stress to cause slip on the basal planes was only one-fifth of that on the prismatic planes at room temperature, but this difference narrowed as the temperature rose. During the discussion it became apparent that beryllium could be considered as two different materials according to methods of preparation; that the relatively pure metal made from the electroylic flake had different properties from that made by the powder route which contained oxide: and that these materials were used for dissimilar purposes.

Although present-day beryllium is still impure, the improvements in purity already made have been accompanied by a better ductility but lower strength, and this reduction in strength has made the metal less acceptable in some circumstances. It was suggested by Ellis (A.W.R.E., Aldermaston) that in future beryllium or its alloys will be tailor-made for particular requirements.

Deformation and Fracture

The next session on deformation and fractures had as its Rapporteur, Dr. J. Bishop. Work done on single and multi-crystalline aggregates has shown the effects of impurities on glide on the basal and prismatic planes. During deformation, lattice rotation which accompanies this basal slip will increase the resolved shear stress on the planes which have very limited ductility, so that the total deformation is limited. Slip is even further reduced by the necessity for accommodation at grain boundaries, at surfaces and hard inclusions. Sheet material could be prepared with two-dimensional ductility, but it was difficult to make sheet material with three-dimensional ductility. Work had shown that grain refinement improved ductility.

In the discussion, several speakers drew comparisons between the behaviour of beryllium and other hexagonal metals, several of which have quite satisfactory ductility.

High-Temperature Ductility

The next session was on elevated-temperature ductility, the Rapporteur being Dr. H. K. Hardy.

Dr. Hardy considered strength properties of beryllium, pointing out that the thermally reduced material made from the powder route was stronger than that made from the electrolytic route and subsequently cast into ingots. Maximum strength occurred at about 400°C. but strength was reduced at lower strain rates.

Discussion was largely concerned with the effects of iron and the formation of grain boundary precipitates: fractography had been used at Windscale to investigate the formation of voids in specimens at high temperatures and there was some evidence of a grain boundary phase which acted like a liquid. It was suggested that

this phase could be dispersed by suitable thermal treatment so that the ductility trough at 600°C. could be avoided.

Ductile/Brittle Transition

Consideration of mechanical and physical properties continued in the next session when the ductile/brittle transition was considered with Dr. A. A. Johnson as Rapporteur. Of the five Papers considered, four were from the Atomic Weapons Research Establishment at Aldermaston. It was shown in these that the rapid increase in ductility with rise of temperature above room temperature was similar to that found in body-centred cubic metals. The temperature at which this brittle/ductile transition occurred was increased by larger grain size and rate of testing. Beryllium also has an unusual property in that it has a yield point with the yield spreading from a notch by Lüders bands. Hydrogen was only sparingly soluble in beryllium, to a limit of about two parts per million, and was adsorbed on surfaces.

In the discussion, Martin (A.W.R.E., Aldermaston) said that at a grain size of about 12 microns it should be possible to increase the maximum ductility, lower the temperature brittle/ductile transition, and raise ductility of the metal when it was in its brittle region.

Prof. N. J. Petch acted as Rapporteur for a continuation of discussions. He gave a characteristically provocative talk, saying that if beryllium did become an industrial metal it would give great satisfaction to the theoretical metallurgists who had been concerned with its development from the beginning, unlike the case with other metals of commercial importance. He agreed with some of the comments which had been made that the attempts to apply theories of brittle behaviour to beryllium had been made difficult by its different lattice arrangement. Nevertheless, he thought this attempt had been well worth while and had cleared the way for a more realistic appraisal. Improvement in properties as grain size was refined was a most rewarding approach, but it revealed our ignorance on such subjects as crystallization, recrystallization and the relationships between grains, sub-grains and substructures.

Beryllium in Reactors

The first session of beryllium in reactors was devoted to corrosion and compatibility, with Dr. Woodfine as Rapporteur. Three of the six Papers he considered dealt with the reaction of beryllium with carbon-dioxide coolant. Beryllium reacts with many oxides at temperatures as low as 550°C. After oxidation in air, a film is formed which is protective up to 750°C., but at higher temperatures break-away corrosion can occur. Alloying appeared to confirm no beneficial effects; on the other hand, pre-oxidation had shown some improvement in resistance, possibly by blocking grain boundary attack. Moisture accelerated break-away corrosion.

In the discussion, it was said that beryllium carbide contact had an important effect on the initiation of break-away corrosion. Metal produced by the powder route had a larger surface area at the grain boundaries than that made from ingot material, but a protective film of oxide existed. Working might rupture this film and increase the rate of attack.

Irradiation Effects

In reviewing irradiation effects, Dr. G. B. Greenough said that, while he had only five Papers to consider, because of the difficulty of this type of work and the time consumed in carrying out experiments, these did, in fact, represent a very great amount of experimental effort. Difficulties with carrying out irradiation experiments are in obtaining uniform conditions between different samples, particularly temperature and total dose. Beryllium is unusual in that it has a reaction with neutrons with the formation of helium gas bubbles. At lower temperatures, below 500°C., there is an increase in hardness accompanied by a decrease in ductility: at temperatures above this, gas bubbles form and the size of the bubble increases at higher temperatures, resulting in swelling in the metal, but little hardening at these higher temperatures.

Bubble formation had been studied by fractography at Windscale. They had been found to be widely dispersed, including some at the grain boundaries. An Australian delegate showed a series of very interesting and beautiful slides of bubble formation.

Metallurgical considerations were reported by J. Williams. Extrusion of tubes suitable for carrying nuclear fuel elements could be carried out at 600°C. by using silver as a lubricant. Other metals have been employed, but there were difficulties in controlling accurate sizes, although methods of doing so have been given in various Papers. Inspection of beryllium tubing was made difficult by the properties of the metal.

Aircraft Applications

R. A. Clare was Rapporteur for the session on beryllium in aircraft. He said that the four Papers given in this section did not represent the interest that had been shown by aircraft/space engineers in this material. To combat its low ductility, new techniques were required and particular care in design; for example, edge reinforcement would be required and this might introduce a weight penalty. Other Papers described the forming of beryllium at high temperatures and the use of the metal in particular sectors. In the discussion, higher strength at high temperatures was called for and this was in conflict with the properties of purer beryllium. It was not known what amount of elongation was actually required for service use, but it was hoped that experience would reveal requirements in this respect.

The first section in metal preparation and fabrication dealt with pure metal preparation. Beryllium is a difficult metal to purify and will absorb impurities even from an argon atmosphere, so that the best method of purification is that which is carried out at the lowest temperature: a second difficulty is the reliance to be placed on analytical results, crucible materials introduce problems of contamination even when beryllia is used. Other methods than analysis have been used for estimating purity, such as changes in mechanical properties shown by bend tests, etc.

An important Paper related to this section was given by Prof. Ivanoff, a Russian delegate. He said that the brittleness of beryllium depended for a large part on its purity. Tensile elongations of pure beryllium were three to five times those for commercial purity metal. This was not only due to the critical stress within the crystals but also the freedom from impurities at the grain boundaries. The Russians had made very high purity metal by a vacuum distillation process and had been able to obtain deposits of three different textures on which experiments could be carried out. The residual impurities which were difficult to remove were oxygen and carbon, the former from residual gas in the vacuum chamber, and carbon from oils in the vacuum system. He confirmed the polymorphic change from the hexagonal lattice to a body-centred cubic structure at 1,250°C. Their results for the lattice parameter measurements showed a striking difference from those obtained at Aldermaston for the parameter in the "C" direction; this was attributed to the high purity of the Russian beryllium.

Diagnostic Techniques

Dr. G. E. Darwin was given the task of reviewing three different Papers under the title of diagnostic techniques. He considered the Paper on health physics as a valuable contribution, but would like to know the ratio of health physics to production of workers. Another Paper showed that the impurities present in beryllium could be revealed by X-ray microscopy because of the very low absorption of beryllium. It had been noted that the lattice parameter varied through a single crystal, indicating that some elements were in solution near the grain boundaries. The third Paper was concerned with the making of beryllium alloys so that compounds could be identified in commercial grade metal.

In the discussion it was said one-quarter to one-third of the final cost of processing beryllium resulted from the toxic hazard. Airborne limits

in themselves were not particularly important unless particle size was taken into account, since only the smaller particles are likely to be taken into the lungs.

Alloys of Beryllium

Beryllium-based alloys were reviewed by Dr. A. E. Churchman, who said that he had only four Papers to consider, which was a surprisingly small number compared with the number of those submitted on purification. Most metals form compounds with beryllium, which restricted the advantages to be gained. Alloying could be used to improve one quality, but generally impaired another. So far, attempts to reduce the temperature at which the beta-phase is stable had not been very successful. In the discussion it was reported that a calcium-beryllium alloy had shown good resistance to carbon dioxide at high temperatures and pressures.

Ingot and Powder

The session on ingot and powder had for its Rapporteur W. W. Beavers. He said that the methods of production which were considered in the Papers were arc melting and pressureless sintering; other methods of forming solid beryllium were available, such as vacuum induction casting, electric melting, permanent mould die-casting, continuous casting, hot pressing, and fabrication of powder in cans. Rapid cooling of beryllium ingots will cause cracking. Cast metal has a comparatively low oxide content and this is the principal difference between the material produced by two different routes. However, beryllium oxide will give strength at high temperatures, and this is an advantage even when accompanied by low ductility. In material produced by the powder route, the density after sintering was affected by particle size, shape and the compressive load used. Iron appeared to aid sinterability, possibly because it inceased lattice strain and, therefore, the energy available on the grain boundaries. In the discussion which followed it was said that, at Pechiney, ingots were being produced by arc melting which were 15 in. diameter and 36 in. long. The electrolytic route is also being used to refine material to very small amounts of iron and other impurities.

Forging

The Rapporteur in the session on forging was G. C. Ellis. Forging had received less attention than rolling of pressed powders, but this neglect is now being rectified in U.S. Generally, powder - based material is used, although cast material is much cheaper and the usual route with other metals. Forging of bare metal should, in fact, be the cheapest production route. Forging is interesting, not only for the shaping of special components but also to give sound metal for rolling. It was shown that grain size was almost as important as texture in determining the properties of the forging.

In the discussion it was said that the forging of bare beryllium could be carried out in a normal workshop at 350°C. with no particular precautions taken to protect workers against the inhalation of dust. Three methods of production with forgings were available: (i) powder forging at high temperatures; (ii) powder forging at low temperatures; and (iii) forging of solid material.

Of these, powder forging at low temperatures gave the best material.

Rolling and Extrusion

Rolling and extrusion were dealt with by L. R. Williams. In the Paper which compared the extrusion of powder made from the electrolytic and the thermal routes, the extrusion was carried out in steel cans, and glass lubrication was found to be an advantage. Close control was required of the fabrication process, and this applied also to metals being rolled in mild steel picture frames. Success in forming sheet depended upon the rate of strain.

Wrought Metal

Dr. N. F. Eaton surveyed a single Paper on wrought fabication of beryllium metal. Beryllium should not now be regarded as a difficult metal as it had been shown that it was not inherently brittle. It was only in 1957 that concentrated work was started in America, and this has been largely devoted to manufacture of components for air/space vehicles, while in Western Europe interest has been mainly in using it as a canning material in reactors. In fabricating loose powders, considerable oxygen pick-up may take place, and the movement or rotation of grains during the pressing may result in textural difference and directional properties. Routes where beryllium had been encapsuled were economically disadvantageous because of the cost of the canning and the decanning, and also the possible contamination of the beryllium surface. Dr. Eaton asked for a move towards standard metallurgical processes; by that, he meant melting and casting metal.

In the discussion, the point was made that the powder route was used only because of the difficulty of casting sound ingots of beryllium and the high cost of arc melting. The powder route has repeatedly been shown as a feasible way for making particular parts.

Joining Techniques

The Rapporteur for the session on joining was Mon. J. L. Bernard. The advanced gas cooled reactor development programme had led to the development of techniques using high-temperature brazes. In some instances small holes were found, and tests showed attack by carbon dioxide at these points. In joining beryllium itself to other metals, silver had been used, and wetting had been improved by painting the joint with titanium hydride. Aluminium - silicon alloys could also be used in making high-temperature joints. In fusion welding, grain growth and cracking were the principal difficulties, but could be partly controlled by the choice of suitable geometry and heat input. Electron beam and arc welding had been successfully employed. Pulsing the electron beam gave considerable grain refinement, this effect having been found with other metals.

Dr. Craik said that the grain refinement by this pulse technique was shown by metallography to be because the metal had been melted and solidified rapidly in overlapped zones.

Future Developments

The final Rapporteur in the Conference, Dr. R. Berry, opened the final discussion. Dr. Berry said that a wide range of modern techniques had been used in the study of beryllium. The investigators had been trying to find perfect metal, but he pointed out that many of the metals of commercial importance are far from perfect. He wondered if this was now the time for an important break-through in the metallurgy of beryllium. It should be borne in mind that the requirements of the atomic energy and of the air/space industries require different materials. He did not think that the economics of beryllium had been sufficiently closely studied, since it would only find employment if it could be shown that its properties were superior to those of other materials at that particular cost. He said, for example, that zone refining was a costly process and would deter an engineer from material prepared by this route. The major difference he could see between the aircraft industry and the atomic energy industry was that the former would require metal that could be processed in a jobbing shop, whereas in the atomic energy industry longer runs and more standard products were required. An aspect which he was interested in as an industrialist was the recycling of scrap, which should be taken into account in considering the economics of the process.

In the discussion that followed it was pointed out that there had been a vast incease in the production of beryllium over the last ten years, accompanied by a substantial drop in price. L. Grainger (A.E.R.E., Harwell) explained that use of beryllium in the advanced gas-cooled reactor at Windscale was to be based on economic assessment; this was an extremely complicated process as it concerned the economics of fuel which could be used, reactor gas outlet temperature, and the part such a reactor would play in relation to other power-producing reactors.

Several speakers emphasized the fact that supplies of beryllium could be assured for the immediate future.

OUT OF THE MELTING POT

Like Others WITH the development of vacuum arc melting and casting, tungsten is no longer an exclusively powder-metallurgical product. References to cast tungsten appear more frequently, and one has the impression that a report on the shell-mould or investment casting of tungsten might well appear any day now. One can even, perhaps, visualize the production of at least rudimentary shaped castings by combining vacuum arc melting of a consumable tungsten electrode of suitable diameter with appropriate manipulation of it and/or of a support or "starter" to achieve controlled deposition of the metal and the building up of some required shape, i.e. a process that could conveniently be called free casting. In the meantime, however, vacuum arc melted tungsten is still being obtained in the form of ingots, which are then forged or otherwise mechanically worked to the required shape. In this connection the fragmentary information available hitherto regarding the recrystallization of tungsten has recently been enlarged by a complete recrystallization diagram for commercial purity (99·6 per cent) tungsten. The metal was deformed by free forging at 1,100-1,700°C., which, in the case of tungsten, amounts to cold or at most warm deformation. Forged specimens with a degree of deformation ranging from 6 to 90 per cent were annealed in a vacuum or hydrogen at 1,000 to 2,500°C., after which they were hardness tested and examined microscopically and by X-rays. Features of the recrystallization diagram include the commencement of recrystallization at 1,450°C. for deformations between 30 and 90 per cent, recrystallization between 1,450 and 1,600°C., and secondary grain growth from 1,700°C. upwards. Like other metals, tungsten exhibits a critical deformation which causes coarse grain growth on annealing and which decreases from 12 per cent for an annealing temperature of 1,600°C. to 6 per cent for 2,100°C. For a fine equiaxed grain, metal deformed between 50 and 90 per cent should be annealed between 1,500 and 1,600°C.

Obfuscation EVERY science—even metallurgy—has a language of its own. Its detractors claim, often with truth, that some of it is deliberately obscure so that the layman can be blinded by it. What, I wonder, would they make of this random extract from a Paper entitled "Laws of Physical Laws"? ". . . It is also possible to frame all normative, metanomological statements as if they referred only to modes of observation and, moreover, to observation in itself—not the observation *of* some physical system or event. Thus certain quantum-mechanical postulates can be given an operational flavour by replacing in them 'dynamical variable' by 'observable'—although the quantum-mechanical operators called observables are related to the observational data in a very indirect fashion. In this way, it is possible to force these statements into the Procustean bed of the philosophical prescription according to which 'Physical theories should consist only of relations among observable quantities, and should have as their sole aim the prediction of empirically obtainable quantities'. But such a reformulation of nomological and metanomological statements in terms of observations and of observation predicates is a verbal manoeuvre and obscures the actual situation by giving those statements the appearance of referring *solely* to human experience, and not to nature as well. Moreover, they can perform a persuasive rather than a clarifying function since their aim is to persuade us that the variables of theoretical physics are not elaborate constructs, the (rational) values of which are assigned through long and twisted theoretico-empirical procedures but are observational terms like the colour and taste names, nicely complying with the requirements of a narrow sort of empiricism. True, normative metanomological statements are not laws of nature but prescriptions regarding laws of nature, and can consequently be used as heuristic clues for the invention of further law statements. But this does not detract them from referring in a mediate way, to the referents of the law statements themselves . . ." This, to my simple mind, provides further support for that rather unkind definition of philosophy as a systematic elaboration of a terminology specially invented for the purpose.

All Set HYDRAULIC extrusion of metals is still a laboratory curiosity so far as accounts of it in the literature are concerned, though the news of its first application on a commercial scale should not be unduly surprising. In this process a billet of the metal is placed in a hydraulic pressure cylinder, with the suitably shaped end of the billet fitting into and closing the extrusion-die opening which constitutes an outlet from the cylinder. Hydraulic pressure, applied to the billet, forces the billet out of the cylinder through the extrusion die. Advantageous factors include lower extrusion pressures, the presence of a film of the liquid (which may be arranged to have suitable lubricating properties) on the surface of the metal as it passes through the die, and a microstructure of the extruded metal which is much more uniform than that of conventional mechanically produced extrusions. To these fundamental advantages there could, no doubt, be added numerous other improvements once the adoption of the process on an industrial scale has started to inspire ingenious inventors. A typical improvement of this type relates to the hydraulic extrusion of a pre-formed rod, and more specifically to a method whereby a large reserve of the product to be extruded can be accommodated within the hydraulic cylinder. This is achieved by forming the rod into a single or double helical coil. The end of the rod is fitted into the die opening in the usual way. As extrusion proceeds, the helix uncoils inside the cylinder and a straight rod, of reduced cross-section, is extruded. The procedure can be used to produce cored extrusions from a rod inserted into a tube. For example, 100 kg. of a copper-clad aluminium conductor, 6-7 mm. in diameter, can be produced.

Skimmer

Aluminium Rolling in New Zealand

NEW ALCAN INDUSTRIES PLANT FOR FLAT, COILED AND CORRUGATED PRODUCTS

WITH an initial capacity for the annual production of 5,000 tons of aluminium sheet and plate, New Zealand's first aluminium rolling mill, the £2,500,000 Alcan Industries Limited plant at Wiri, Auckland, will be able to meet virtually the whole of the country's present requirements of material of this kind.

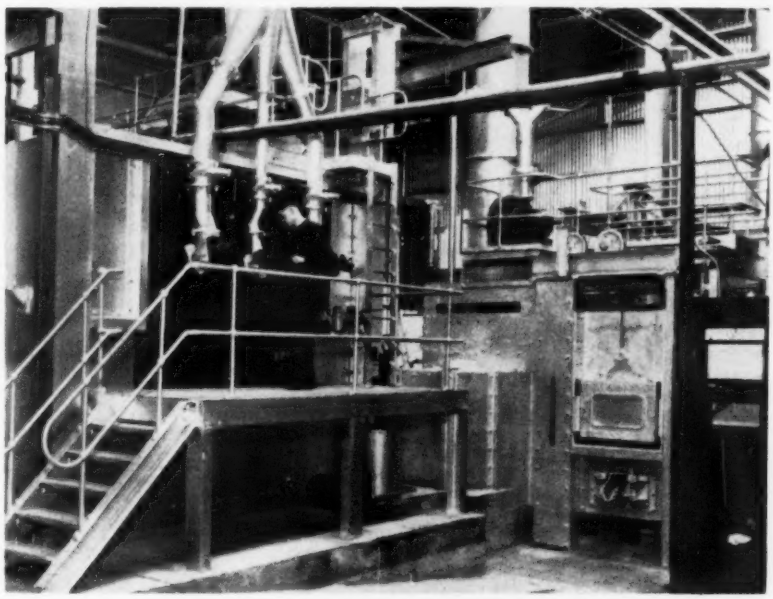
The new mill, with a sales organization, forms the New Zealand branch of the United Kingdom company Alcan Industries Limited (a member of the Aluminium Limited of Canada Group of companies). Opened recently, it comprises a complete production unit with furnaces, semi-continuous casting unit, hot and cold rolling mills, and ancillary equipment. Its main products are flat and coiled aluminium sheet, aluminium plate, various types of corrugated building sheet, circles for subsequent pressing into hollow-ware, and slugs for the production of impact-extruded items such as tubes for packaging.

In a normal sequence of rolling operations in the mill, aluminium, imported from Canada, is first melted and alloyed as necessary in a 24,000 lb. oil-fired Priest reverberatory furnace. From here, the metal is passed to a holding furnace situated alongside a semi-continuous casting unit, in which the rolling ingots are cast.

Before hot rolling the ingots are preheated in a Gautschi electric furnace; hot rolling is carried out on a 72 in. 2-high Brightside reversing mill, which in normal operations converts an ingot 8 in. thick to a $\frac{3}{8}$ in. slab.

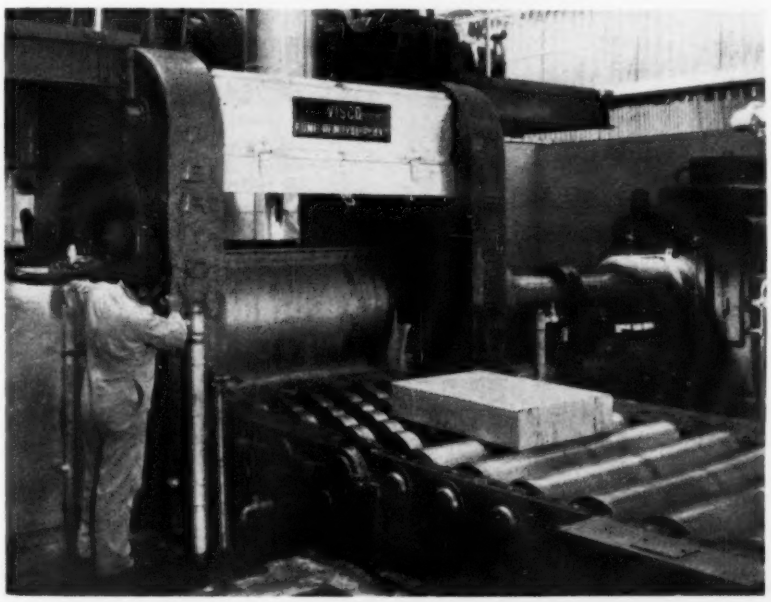
From this stage the aluminium is worked cold, the slab being rolled to finished thickness in two stages—with intermediate annealing—on a Robertson 4-high reversing mill. After cold rolling, the coiled sheet goes either to a slitter or to a cut-up line, according to whether it is destined to be despatched as coil or as sheets. The cut-up line comprises spools to hold the coil, a nine-roll roller leveller, an embossing machine, and a shear.

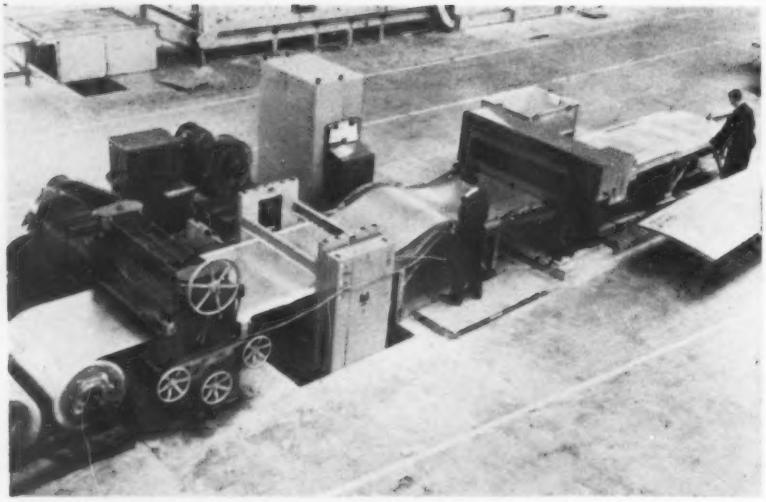
Sheets for building purposes are sheared to size and then passed to a 150-ton Bronx brake press, where they are corrugated according to the profile required. Tools are available for the familiar "circular" corrugated sheet and for several patterns of full-size and miniature troughed sheets. Those sheets that are for general engineering or industrial use are flattened in a 250-

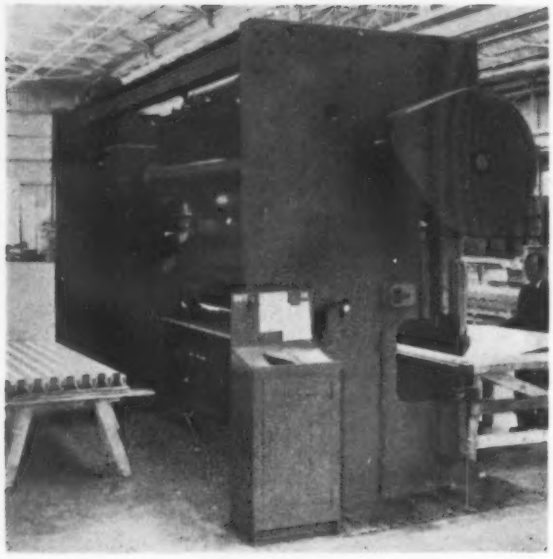


Oil-fired 24,000-lb. remelt furnace at the Alcan Industries Limited aluminium rolling mill at Wiri, New Zealand

Ingot being rolled to $\frac{3}{8}$ in. slab on the Brightside 72-in. reversing hot mill







Cut-up line and embossing machine at the Wiri aluminium rolling mill

Noral Industrial type building sheet being formed on the 150-ton 20-ft. Bronx brake press

ton Fielding and Platt stretcher, which is capable of handling sheets 5 ft. wide and 20 ft. long, and plate up to 1 in. thick.

A Rhodes mechanical press is installed for the production of aluminium slugs, which are punched from sheet or plate, and of circles up to 15 in. dia. Larger circles, up to a maximum of 4 ft. diameter, can be produced by means of circle cutters. For small quantities, and for extra-wide sheets, there are two 84 in. Brightside flat sheet mills. An indication of the self-contained nature of the plant can be gained from the fact that, in addition to the usual ancillary and maintenance machinery, there is a Craven machine for roll grinding.

A significant feature of the works is that the 5,000 ton annual output of which it is capable in its present form can be substantially increased as necessary simply by the addition of further cold-rolling facilities, since the hot mill already has a much greater capacity. Foundations have been prepared for a foil-rolling mill, which should be in operation by the Spring of next year, and there is provision for the eventual production of aluminium wire and cable.

The works buildings, which are largely clad with aluminium, cover 125,000 ft² and stand on a 32-acre site close to the main highway south from Auckland. The mill is housed in two 500 ft. by 80 ft. bays, each equipped with overhead travelling cranes; these have a capacity of 25 tons in the hot mill bay and 10 tons in the cut-up bay. The remelt, motor room, stores and tool room form annexes to the main bays; fuel storage, water cooling towers and the pump house are separate from the main building. Initially it is expected that some 300 people will be employed.

MEN and Metals

On Monday next, **Dr. G. L. J. Bailey,** Ph.D., D.I.C., F.Inst.P., F.I.M., will be inducted as President of the Institute of Metal Finishing at the annual general meeting in London, and will afterwards deliver his Presidential address.

On January 1 next, **Mr. C. R. Wheeler,** C.B.E., becomes deputy chairman of Associated Electrical Industries Limited, and will also be deputy chairman of the A.E.I. management companies. Mr. Wheeler is this year's President of the British Iron and Steel Federation, and was President of the Iron and Steel Institute for the year 1958-59.

For six years a member of the board, **Mr. Joseph Samuels** has been appointed managing director of Winston Electronics Limited. **Mr. W. Allan Bridges** continues as chairman of the board.

A new division—the Core Binder Division — of Foseco International Limited is to be under the managership of **Mr. R. S. Bushnell.** This division will be responsible for servicing both the licensees and agents of Foseco/Fordath A.G., a company which has been formed following upon the recent agreement between Foseco International Limited and Fordath Engineering Company Limited.

It has been announced that **Mr. Vernon H. Willey** has been appointed by Firth Cleveland Steel Limited to a special post with the company as marketing manager—stainless steels.

Appointed manager, industrial applications engineering department, Rugby and Manchester, AEI motor and control gear division, **Mr. E. L. N. Towle,** B.Sc., M.I.Mech.E., M.I.E.E., M.I.Mar.E., succeeds **Mr. B. Pringle,** M.B.E., whose retirement was recently announced.

A senior director of the William Kenyon group of companies, **Mr. Frank Kenyon** was elected chairman of the Federation of European Petroleum Equipment Manufacturers at its recent annual general meeting in Marseilles.

Owing to company expansion, **Mr. Ray Cupitt,** sales representative for the past three years for the Wigan factory of Metaducts Limited, has been appointed personal assistant to the managing director of the company.

It is reported that **Mr. V. A. G. Lambert,** deputy chairman of Projectile and Engineering Company Limited, has been appointed chairman of the company in place of the late Mr. J. Waddell.

It is learned from the United Kingdom Atomic Energy Authority that the National Institute for Research in Nuclear Science has appointed **Dr. J. Howlett** as head of their Atlas Computer Laboratory at Harwell. The appointment takes effect as from today.

Cost Control in Gravity Die-Casting

By R. R. Woodward
(*High Duty Alloys Ltd.*)

(*Concluded from* METAL INDUSTRY, 24 *November* 1961)

CASTING qualities in the form of soundness, definition, surface finish and accuracy, are inherited from the shape of the impression in the die and the manner in which the alloy is allowed to fill the impression, solidify and subsequently be removed as a casting.

Additional capacity for molten alloy surplus to that which is required completely to fill the actual casting impression must be provided in the die in the form of riser cavities, otherwise, as the molten alloy begins to solidify, the 5 per cent to 8 per cent reduction in volume, which takes place as the alloy reverts to its smaller solid volume, will result in the formation of shrinkage defects.

The definition imparted to the casting by the shape in the die is mainly dependent upon the pressure existing within the poured alloy, which forces it outwards to make intimate contact with the die's impression surfaces. This pressure is exerted by the hydrostatic head created by the influence of gravity on the mass of molten alloy comprising the surplus already referred to, plus the volume of molten alloy within the filled impression.

When the alloy is poured into the die in a manner which gives turbulent conditions under the influence of gravity, defects due to entrapment of air and oxide skin folds can occur. To overcome these, the die must have carefully designed runner channels into which the alloy is poured, and these control the direction of flow and speed of entry, whilst carefully positioned vents allow the egress of air and gases from the impression cavity.

By study of the foregoing, it will be seen that to safeguard quality a good die design must have "in-built" features for controlling the fundamentals mentioned. Although these features are essential for the production of a good casting, the method of incorporating them in the design can have drastic effects upon the casting cost.

Yield

The yield or saleable amount of cast alloy in relation to total amount of alloy poured per casting cycle is of paramount importance in view of overheads, melting and fettling costs. Despite this, probably the most commonly used method of running gravity die-castings in Britain is still that of side or base runners used in conjunction with top feeding risers. Although in specific cases this practice cannot be avoided, it is not generally appreciated that it requires a greater amount of re-melt because near bottom ingating sets up adverse temperature gradients in the die and casting, which do not induce progressive feeding. The incoming metal gives up some of its

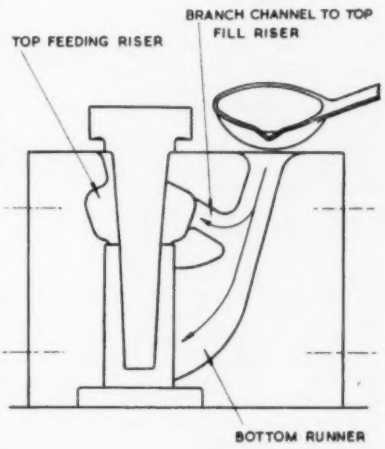
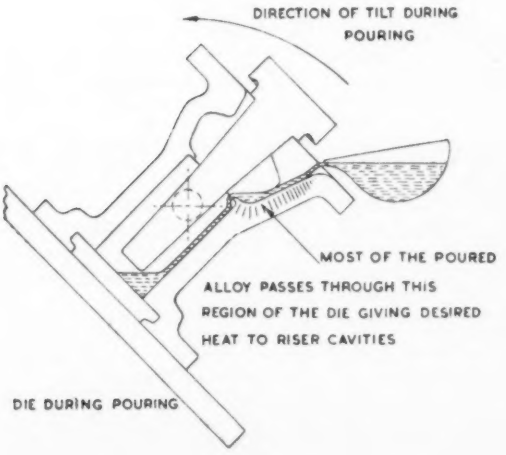


Fig. 8—Branch channel provided to feed top riser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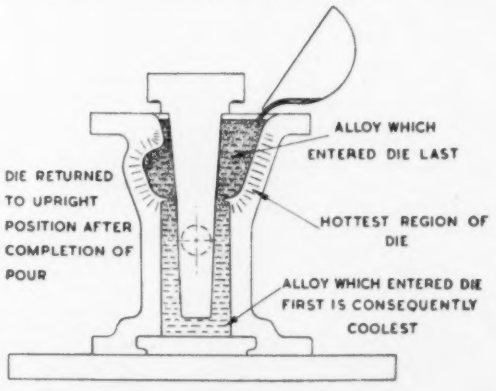

ALLOY WHICH ENTERED DIE LAST
DIE RETURNED TO UPRIGHT POSITION AFTER COMPLETION OF POUR
HOTTEST REGION OF DIE
ALLOY WHICH ENTERED DIE FIRST IS CONSEQUENTLY COOLEST

Fig. 9—Tilting the die (left) during pouring avoids turbulence and provides heat for riser cavities. As pouring is completed (below) the die is returned to the vertical position

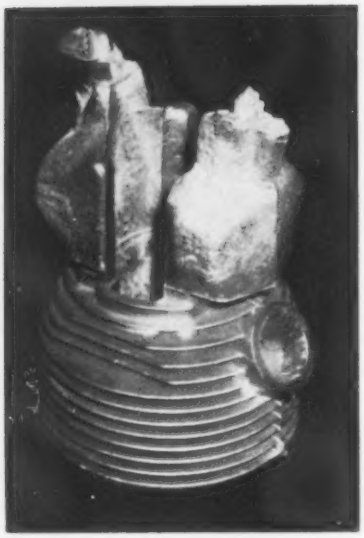


Fig. 10—Finned cylinder head of the type successfully produced by top riser pouring

heat to the lower regions of the die, and the last metal to be poured, which is consequently at the highest temperature, remains in the bottom runner system. The metal, which subsequently fills the top risers, has to pass through lower sections of the die, thereby losing heat.

One way of attempting to overcome unfavourable temperature gradients is to provide branch channels from the bottom runner to top fill the riser system, short circuiting or by-passing unnecessary die travel when the casting impression is approximately full. This method is illustrated in Fig. 8. The majority of the poured alloy has, however, still passed through the lower regions of the die and the risers top filled, as described, will need to be large to have a heat content such that solidification takes place first in the casting and not the top risers.

The ideal way to produce favourable temperature gradients in the die is to dispense entirely, wherever possible, with bottom or side runners and to pour direct into the top risers. The whole of the alloy poured into the die passes through the top, and the resultant temperature gradients help to ensure that solidification progresses from the bottom of the casting upwards, terminating in the top risers. The problem with this method is the turbulent pour which results if the molten alloy is poured direct into the top risers and is allowed to fall the height of the die. To overcome this problem, partial inversion of the die is necessary. This method, which is that adopted on the machine depicted in Fig. 6, is shown in Fig. 9.

Study of the economics of die manufacture will reveal that the cost of a pair of standard trunnion bearings (cost approximately £2) and an air cylinder controlled from a foot-operated air valve (combined cost approximately £20) are the essential requirements to facilitate mechanized part inversion or tilting of the die during pouring. The addition to the die price has only to be met once, but the increased casting cost occasioned by the large runner/riser/casting re-melt ratio due to bottom running, occurs on every casting produced and is a permanent burden. In addition, the fettling cost for the method in Fig. 8 would be approximately twice that for Fig. 9.

It may be argued that few castings lend themselves to direct top riser pouring, but the method described has been successfully used on finned cylinder heads, as illustrated in Fig. 10.

The size of runners and risers and their positions in relation to the casting are mainly dependent upon the casting design and the position of the parting planes in the die. It should be noted that for a given size a riser will feed more efficiently if the movement of the alloy from it to the casting is assisted by gravity. Feeders may have to be positioned below the casting sections which they have to feed, and side shrink pads are commonly used, especially in the piston casting industry. In these cases, the hydrostatic head, created by the molten alloy in the filled casting impression, and top risers, tends to oppose the movement of alloy from side risers, and the only real inducement for movement of feeding alloy is atmospheric pressure. In these instances, therefore, it is advantageous to expose at least one riser surface to atmosphere and blind risers should be avoided wherever possible.

In general, the larger the mass of alloy cooling in the die in relation to the combined surface areas of casting and risers contacting the die, then the longer will be the cooling time and, hence, the slower will be the production rate if the natural cooling effect of the die is relied upon. This implies, of course, that wherever possible the ratio of the volume in the form of runners and risers added to the volume of metal in the casting should be kept to a minimum, if only for production rate reasons.

One method of reduction in the amount of re-melt is to foster in the die design correct heat balance by attempting to arrange for the larger masses of iron or steel to be concentrated where they will act as heat reservoirs for keeping the risers alive and arranging to reduce die wall thickness adjacent to the casting. By study of the thermal characteristics as described and to facilitate production of sound castings, gravity dies can be given means for rapidly extracting or delaying, as required, the heat transfer from the poured alloy. Dies are constructed usually of cast iron or steel, and by assisting the thermal properties of these materials a means of governing the rate and direction of solidification of the casting can be provided. For instance, the fixing of properly tailored gas burners in position against the rear of the die wall directly behind risers is by far a more economical means of achieving riser efficiency than addition of riser material. Conversely, to speed up the solidification rate of the casting by the use of air- or water-cooling is more effective than relying on natural die cooling.

Fettling Costs

One common method of helping to reduce fettling costs, which is gaining increased usage in the U.S.A., is to arrange for the gate design to be such that it permits the caster to fracture off runners and risers after he removes the casting from the die. This is made possible by having gates which have a notched design, but this approach should not be allowed to restrict the feeding efficiency. Usually, a good guide to gate size in the runner is the thickness of the adjacent wall of the casting. If a full stream of metal is required to spread out from each side of the gate, then the gate should be about twice the wall thickness, but where this effect is not required the gate should normally be the local general casting thickness.

Restriction of the gates to one face of the casting allows easy removal of re-melt by circular sawing, which is becoming more commonly used and is far more accurate than band sawing.

The incorporation of fettling beads to the external design of castings, on to which can be sited the gates for runners and risers, can usually be negotiated with the customer to avoid, wherever possible, gating on to curved or shaped surfaces.

When flat surfaces of the castings are to be subsequently machined by the customer, then these surfaces should be the target positions for gating provided jig locations are not obstructed. On such surfaces, provided the depth of cut during machining is not seriously affected, most customers will accommodate the sawing-off witness left by runner and riser removal. This concession can obviate the necessity to carry out further fettling operations after band or circular sawing.

Conclusion

In this article, the author has attempted to outline the constant problem which is faced by those associated with gravity die design. The overriding factor is the influence of the design upon the economics of casting production. The main weapon in the hands of the designer is experience and know-how backed by the offspring of invention, which is ingenuity, plus general scientific engineering advancement.

The author would like to take this opportunity of thanking the directors and management of High Duty Alloys Ltd. for their kind permission to use the major portion of the material in this Paper, and for their help and co-operation in its preparation.

Industrial News *Home and Overseas*

Mobile Maintenance Service

Five firms have recently combined to provide a mobile maintenance service for any site in Great Britain. The new company is **Site Shotblasting and Painting Company Limited,** with headquarters in Birmingham. The companies concerned are the site shotblasting division of R. J. Richardson and Son Ltd., Abbott of Harrow Ltd., Arnold Sharrocks Ltd., W. C. Simpson and Son Ltd., and John S. Craig and Company Ltd.

The company propose to give a complete service to marine and civil engineers and to industry for the cleaning and coating of metal surfaces on site, and we believe that this is the first time that one company has possessed the resources to do such large-scale work from start to finish.

Teams of skilled men, working in self-contained units, will operate from seven centres throughout the country and we are informed that a total labour force of 2,000 will be available for the work. Upon engagement for a complete job to an agreed specification, the company will, it is said, negotiate a form of guarantee.

The chairman of the new company is Mr. G. E. Lunt, deputy chairman of R. J. Richardson and Sons Ltd., which is a member of the Staveley group of companies.

Flame Plating Process

As from today, **Union Carbide Limited** will, it is stated, by arrangement with John Harris Tools Limited, take over responsibility for operating the process at present undertaken by the latter company, who will continue to sell flame plated screwing tools and gauges.

The flame plating process involves the use of a specially constructed gun in which particles of the coating material are suspended in a mixture of oxygen and acetylene. When this mixture is ignited, a detonation takes place which heats the particles to a plastic state and hurls them from the barrel at a supersonic velocity, so that they embed themselves in the surface of the workpiece. A microscopic welding takes place, resulting in a tenacious bond.

By means of successive detonations, the coating on the workpiece may be built up to any desired thickness over a range from two to ten thousandths of an inch. The coatings can be applied on most metals and their alloys, and one of the advantages claimed for this process is that the temperature of the workpiece seldom exceeds 400°F., even though the temperature of the gases inside the gun may reach as high as 6,000°F.

Italian Aluminium Project

It is reported from Milan that the board of Societa per Azioni Lavorazione Leghe Leggere, of Milan, announced their decision to carry out the construction of a new hot-rolling plant for production of large sized aluminium plates. The site of the plant has still to be determined. Its output will meet all the domestic requirements expected in the future for aluminium and its alloys in rolled-sections for the chemical, transport and shipbuilding industries. In addition, the new factory will make available a large quantity for export to Mediterranean markets, the board added.

The board also announced that in the first nine months of this year, the output of the company increased by 13 per cent over the corresponding period of 1960 due to the continuous expansion of aluminium consumption in Italy. Societa Lavorazione Leghe Leggere belongs 50 per cent to the Montecatini group of Milan and 50 per cent to the Swiss group Sava.

A Marketing Agency

A new company, recently formed, is to market Spirol spring pins in this country. **Spirol Pins Limited** have been appointed sole U.K. sales agents to the C.E.M. Company Inc., of Connecticut, makers of these pins.

Spirol pins are available in diameters of $\frac{1}{32}$ in. to $\frac{1}{4}$ in. and are available from stock in carbon steel, cadmium plated, chrome S.S. and nickel S.S., and in light, medium and heavy duty grades.

Australian Mineral Output

It was stated in Canberra recently by the Minister for National Development that the output of the Australian mineral industry in 1960 reached a record level of almost £A236,000,000. This was well above last year's figure of £A214,000,000 and the previous record figure of £A217,000,000 in 1956. The increase in ex-mine value of output over the 1959 figure was £A16,000,000, and value added at Australian smelters and refineries increased by nearly £A6,000,000, he said. These figures did not include the value of uranium oxide. Complete statistics for uranium oxide production were not available, but the total value of uranium oxide produced is now estimated to be about £A11,000,000 a year.

There were notable increases in production of coal, copper, ilmenite, iron ore, tungsten and zinc, while production of most other minerals also showed an increase over the 1959 level, he said.

Considerable developments were foreshadowed in aluminium, and iron and steel production continued to grow. In the non-ferrous base metal field, lead had a difficult year in 1960, with mine production at its lowest since 1957. However, mine production of zinc had been little short of the record 1957 level and copper had made notable progress, largely as a result of developments at Mt. Isa. Mine production of copper in 1960 had exceeded 100,000 tons for the first time.

Scrap Metals Deal

According to news from Stockholm, the Swedish mining company Bolidens Gruvaktiebolag has established a French subsidiary, Boliden-France SA as part of a project to buy copper scrap and other metals in France for refining in Sweden and re-export to France. The French company, Etablissements G de Vineau, is participating. The Swedish company has a large, modern refining plant at Roennskaer with surplus capacity available, a spokesman said. Copper-bearing materials have been bought from outside sources for some time, to supplement available Swedish ores and concentrates. The company also undertakes customs smelting of scrap.

With French restrictions on exports of copper metal, Boliden will undertake the export of copper-bearing material to Sweden, with subsequent importation of an equivalent amount of copper. The firm currently buys copper material from several countries, including West Germany and Chile.

Accidents

A booklet recently published by H.M. Stationery Office deals with accidents at factories, building operations and elsewhere, how they happen and how to prevent them. It is based on certain accidents notified to H.M. Inspectors of Factories and includes certain accidents concerned with the metal working industries. The published price of this booklet is 1s. 3d. net.

Virgin Zinc Brand

It is understood that the Committee of the London Metal Exchange has approved the following brand of virgin zinc and that such brand will now constitute a good delivery against all contracts maturing as from November 23 last: "Contimex", produced by American Smelting and Refining Company, of Rosita, Coahuila, Mexico.

A Pressurized Container

Under this heading on page 405 of the issue of this journal for November 17 last, reference was made to the Flexi-spray pressurized container recently introduced by **Solus-Schall Limited.** Unfortunately, in the second paragraph, in the phrase reading "materials of high velocity can be handled efficiently", the word velocity should have read "viscosity". As this is an important feature of the performance of the Flexi-spray we are glad to be able to make this correction.

Heating and Ventilating Services

News from the **Brightside Heating and Engineering Company Ltd.** states that the company has received an order to supply heating and ventilating services to the administration office block extensions of Shepcote Lane Rolling Mills Ltd., of Sheffield.

The contract involves extensions to embedded floor coil installations, hot water service and plenum systems. The new plant to be installed includes calorifiers, accelerators, centrifugal fan, heater battery and electrostatic air filter complete with automatic washing system. Steam and condensate mains will run from the plant's existing supply to feed the new plant.

Automatic Control Systems

A new 32,000 ft^2 factory devoted entirely to producing "made to order" automatic control systems began production at Hemel Hempstead last week. The factory, occupied by **Honeywell Controls Ltd.,** on the Industrial Estate, will make equipment to help industries adjust their operations continuously and automatically to obtain "optimum" operating conditions.

Among the products to be made in this factory are units for scanning and logging data for industrial operations, controls for industrial processes, supervisory control

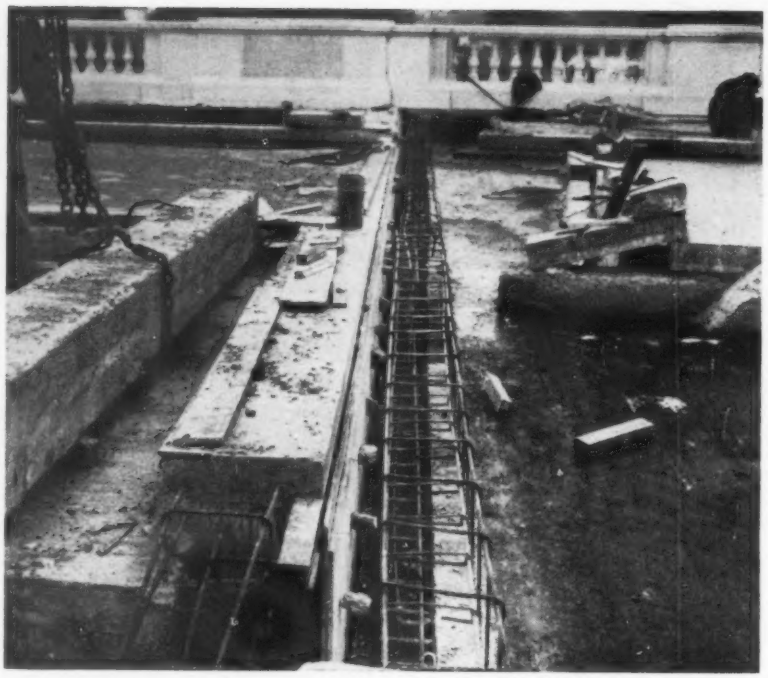
panels for air-conditioning and ventilating systems, automatic analysers for checking flight control systems of aircraft and parts for full-size Honeywell electronic computers.

The opening of this new unit is one of the first events in the celebration of Honeywell's 25th year as a British company.

New Type Expansion Joint

In the construction of the new Runnymede Bridge (Staines By-Pass), a fresh approach to the design of movement joints has been incorporated. Two materials — Delta Bronze No. IV and a plastics composition—have been combined to form a hard-wearing, non-corrosive and watertight joint at the road surface. Basically, the design provides for two bronze angle bars facing each other at the mouth of the joint. The bars are lipped at the lower edge to form a shelf on to which a soft expanded plastics filler is placed which, in turn, is covered with a heavy duty joint sealant, which has sufficient elasticity to give the required freedom for movement. Behind each bronze angle the concrete margin is surfaced with an epoxy resin/sand mortar to give increased resistance to wear and shock.

The reason for devising the new joint was because the consulting engineers believed that modern road usage demands employment of new materials combining strength with resistance to abrasion and corrosion. Some of the problems they were confronted with were the shape of the required bar, method of fixing, and span between fixing points. It was eventually decided to utilize a specially designed angle section which was extruded in Delta Bronze No. IV by **The Delta Metal Co. Ltd.**



Close-up of one of the new type Movement Joints on Runnymede Bridge (Staines By-Pass) which utilizes Delta Bronze No. IV angle bar. The raised portion in the foreground is the centre island, which is designed for simple removal if either of the dual-carriage ways require widening at a future date

The underside of the uppermost angle is tapered to assist the concrete to enter completely into the angle. The top corners were rounded to minimize wear and shock. The bars (approximate total length 410 ft.) have fixing lugs at intervals of approximately 3 ft.

Aluminium "Soldiers"

At the new Sizewell (Suffolk) nuclear power station, where the minimum thickness of the primary walls of the two reactors is 5 ft. 6 in., external shuttering is held by the usual steel "soldiers", and it is formed on the ground, into sections weighing up to 5 tons before erection by crane lifting. This technique is not available internally due to the veritable forest of tubular scaffolding and boards within the walls, and the consequent reduction of practical working space between scaffolding and inner wall surface.

Internal shuttering is therefore erected piecemeal *in situ*, and Taylor Woodrow Construction Ltd. are reported to have drastically reduced the labour and time involved by adopting "soldiers" made of **James Booth** aluminium channel (standard to Specification B.S.1161). Lengths of this channel are mounted base-to-base with a central spacer to allow the insertion of fixing bolts between the two sections. Fixings are left in each section of wall (as it is built upwards), to accommodate these fixing bolts, and the walls are poured in 5 ft. "lifts" between the shutterings thus supported.

Despite the fact that the aluminium "soldiers" are 10 ft. long, dismantling and re-assembly are said to be both rapid and accurate. When the overall contract is completed in 1965, these aluminium "soldiers" will have played a large part in accurately placing well over 12,000 yd^3 of concrete; pourings are normally of 2 yd^3 capacity, or about 4 tons weight, at a time and the channelling is 5 in. by 2½ in. by 3·54 lb/ft. run (extrusion die number 3202 HE30/WP) and coated with zinc chromate.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell by 71 tons to 4,275 tons, comprising London 1,080, Liverpool 1,795 and Hull 1,400 tons.

Copper stocks rose by 486 tons to 15,575 tons, distributed as follows: London 400, Liverpool 13,325, Birmingham 50, Manchester 1,525, Hull 250 and Glasgow 25 tons.

Lead duty-free stocks fell by 175 tons to 8,008 tons, comprising London 7,458, Glasgow 300, Swansea 100, and Manchester 150 tons. In-bond stocks fell by 16 tons to 3,420 tons, all in London.

Zinc duty-free stocks fell by 15 tons to 8,219 tons, comprising London 2,473, Glasgow 46, Hull 325, Manchester 300, Liverpool 50, and Avonmouth 5,025 tons. In-bond stocks fell by 50 tons to 2,873 tons, all in London.

Rhodesian Production

According to figures issued by the Central Statistical Office at Salisbury, the Federation of Rhodesia and Nyasaland

Forthcoming Meetings

December 4—Institute of Metal Finishing. Hotel Russell, London, W.C.1. Annual General Meeting. 2.30 p.m. Presidential Address by Dr. G. L. J. Bailey, 3.30 p.m. Annual Dinner, 7.30 p.m.

December 5 — National Association of Non-Ferrous Scrap Metal Merchants. Midland Hotel, Birmingham. Half-Yearly General Meeting. 11.30 a.m.

December 5—Leeds Metallurgical Society. University Staff House, University Road, Leeds. "Dislocations." Prof. J. Nutting. 6 p.m.

December 5 — Institution of Plant Engineers. Peterborough Branch. Conference Room, F. Perkins Ltd., Peterscourt, Peterborough. "Non-Destructive Testing." F. Hinsley. 7.30 p.m.

December 6 — Manchester Metallurgical Society. Literary and Philosophical Society, George Street, Manchester. "Newer Magnetic Material." Dr. K. Hoselitz. 6.30 p.m.

December 6 — Institution of Electronics. Advanced College of Technology, Gosta Green, Birmingham. Film show on electronic topics. 7 p.m.

December 7—Institute of Metals. Birmingham Local Section. College of Advanced Technology, Gosta Green, Birmingham. "Stress - Temperature Relaxation of Springs." R. Haynes.

December 7 — East Midlands Metallurgical Society. Faculty of Applied Science, The University, Nottingham. "Metallurgy of Tungsten." D. J. Jones. 7.30 p.m.

December 7 — Liverpool Metallurgical Society. Department of Metallurgy, Liverpool University. "Explosive Forming of Metals." Dr. H. Thomas. 7 p.m.

December 7—Non-Ferrous Club. Chadwick Manor Hotel, Chadwick End, Warwicks. Dinner Dance and Ladies' Night. 7.15 p.m.

exported 47,100 tons of copper during August this year, compared with 43,400 tons (revised) in July and 48,400 tons in August 1960. Exports of copper concentrates decreased to 1,790 tons, from 1,834 tons in July, 2,500 tons in August 1960.

Exports of lead during August this year totalled 61,600 centals, against 30,400 centals in July and 39,900 centals in August 1960. Exports of zinc totalled 42,900 centals in August, compared with 41,000 centals in July and 56,100 centals in August 1960.

News from Scotland

It is reported that the **Scottish Mechanical Engineers Training Association** (S.M.E.T.A.) has been formed to undertake a co-operative training programme for six member firms — John Dalglish and Sons, Davy and United Engineering, Lang Gisholt Engineering Company, Mirlees Watson Company, Murray and Paterson Ltd., and Scottish Machine Tool Company. Training will be carried out over a two-year post-graduate period and aims at membership of the Institution of Mechanical Engineers as a logical completion of the process of training. The programme involves initial training, to be done in part or whole during university or college vacations, covering all the basic groundwork. Thereafter, the trainees will go on advanced aspects, including design and development, research, estimating, purchasing, costing, selling organization, administration and management. The trainee will have opportunity during the period of education to sample work within the varied units concerned.

Japanese Aluminium Output

Statistics issued in Tokyo by the Light Metal Rollers' Society state that the output of rolled aluminium in September reached 13,654 metric tons, compared with 13,382 tons in August and 9,678 tons in September 1960. The export contracts for rolled aluminium products in September totalled 636 metric tons, compared with 722·9 tons in August and 818·9 tons in September 1960, while export shipments of rolled aluminium products amounted to 627 metric tons in September, against 707·7 tons in August and 787·3 tons in September 1960.

New Regional Board

On Wednesday last, the inaugural meeting of the new Midland Regional Board of the **Institution of Works Managers** was held in Coventry. This new board comprises the Birmingham, Coventry, Leicester, Northampton, Notts. and Derby, South Wales, West of England and Wolverhampton branches of the Institute.

The first regional officers to be appointed were as follows: chairman, Mr. R. S. Robinson, B.Sc., M.I.Mech.E. (deputy personnel director, Tube Investments Ltd.); deputy chairman, Mr. A. V. Albutt (general manager, Ephraim Phillips Ltd.); and Mr. L. Kew (works manager, B.K.L. Alloys Ltd.).

Non-Ferrous Club

Chadwick Manor Hotel, near Knowle, Warwickshire, is the venue of the annual dinner and dance of the **Non-Ferrous Club,** which is being held on Thursday of next week (December 7). A good attendance is already assured for this event.

On the Tuesday of the following week (December 12), the December luncheon of the Club is to be held at the Ambassador Club, 38 Augustus Road, Edgbaston, Birmingham, at 12.30 p.m. The speaker on this occasion is Mr. Philip Smith, chairman of the London Metal Exchange, and, in view of the interest attaching to this event, early application for places should be made.

Help for Buyers

Under this heading, our leading article this week, on page 433, refers to two brochures which should prove invaluable to buyers. The first of these brochures is entitled "Copper and Copper Alloy Castings", and is published by the Association of Bronze and Brass Founders at the price of one guinea. This is a companion volume to B.S.1400 : 1961, and brings up to date the standard which appeared in 1948.

The second brochure is published by the Metal Finishing Association under the title of "Electroplating and Metal Finishing Standards". The object of this brochure is to provide some general guidance on the large number of finishes now available, many of which are specified in British Standards, and to make for better understanding between purchaser and plater when choosing the best finish for the job, preferably at the earliest possible moment in the design stage.

A Regional Display

A one-day display of engineering products and processes, organized by the North-West Region of **Engineering Industries Association,** was held at Belle Vue, Manchester, recently. The display, the first of its kind to be held in the region, was opened by Mr. Bertram Mycock, industrial correspondent of the B.B.C., and included exhibits from 55 firms occupying sixty stands, and covering a wide field of engineering products ranging from photographs and small components up to complete machines and fabrications.

Among the exhibitors on this occasion were the following: — British Oxygen Company Limited, The Colne Anodising Company Limited, East Lancashire Platers Limited, Expert Heat Treatments Limited, Fletcher Miller Limited, The Johnson Metal Company Limited, and H. Rollet and Company Limited.

Silent Air Drills

An announcement from **B. O. Morris Limited** deals with a new series of Grasso straight-grip pneumatic drills, made in Holland. The chucks are shrouded for safety and almost silent operation, which is welcomed where banks of tools are in use; the bodies are sheathed in easy-to-clean plastics, which insulates the operator's hand from the cold metal, hitherto one of the drawbacks of efficient air tools.

The lever is easily removed, if so desired, to reveal a press button when this type of control is preferred.

Speeds available are 500, 900, 1,500 r.p.m. with $\frac{5}{8}$ in. chuck for stainless steel, Nimonic and other alloys, and 3,800 r.p.m. with $\frac{1}{4}$ in. chuck for general workshop use and for the aircraft, motor, and woodworking industries.

A Wall Chart

One of the latest in their series of education wall charts is that issued by the **Aluminium Development Association,** together with its teachers' notes. The subject is on the rolling of aluminium plate, sheet and strip, and foil, and the two documents are planned—like their predecessors—to be complementary whilst each is complete within itself. In effect the wall chart is suited, obviously, to classroom display and instruction, whilst the teachers' notes, prepared particularly for the instructor in working up a lesson, are also designed for the student's private study.

The notes begin with a historical outline of the development of the rolling mill and then take the student through the series of operations, beginning with scalping and preheating and continuing with the hot rolling of sheet and plate, cold rolling to give a variety of sheet products, and foil rolling. The operations are brought together in a flow diagram and the book concludes with notes on the wall chart, which thus link closely the two parts of this visual aid. The set is priced at 2s.

Metal Cleaning Service

Formation of a new subsidiary company, to be known as **Bladite Limited,** has been announced by the Castrol Group. This new company will specialize in metal cleaning by mechanical means, including shot blasting, in metal spraying, and in

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for September 1961 have been issued by the Aluminium Industry Council as follows (in long tons) —

Virgin Aluminium	
Production	2,425
Imports	12,744
Despatches to consumers	18,026
Secondary Aluminium	
Production	10,186
Virgin content of above	861
Despatches (including virgin content)	11,048
Scrap	
Arisings	13,448
Estimated quantity of metal recoverable	10,013
Consumption by	
(a) Secondary smelters	12,121
(b) Other uses	914
Despatches of wrought and cast products	
Sheet, strip and circles	13,425
Extrusions (excluding forging bar, wire-drawing rod and tube shell)	
(a) Bars and sections	3,928
(b) Tubes (i) extruded	267
(ii) cold drawn	473
(iii) formed strip	—
(c) (i) Wire	1,376
(ii) Hot rolled rod (not included in (c) (i))	46
Forgings	340
Castings (a) Sand	1,695
(b) Gravity die	4,458
(c) Pressure die	2,062
Foil	1,914
Paste	366

the application of protective coatings. The work can be carried out in the company's Liverpool works or on site, where advanced equipment and a new dust-free process will be used.

It is understood that the company will also provide, within the power station, a service for the mechanical removal of the silica deposits which form on turbine blades and diaphragms.

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Machine Mounting.—Cementation (Muffelite) Limited, Hersham, Walton-on-Thames, Surrey.

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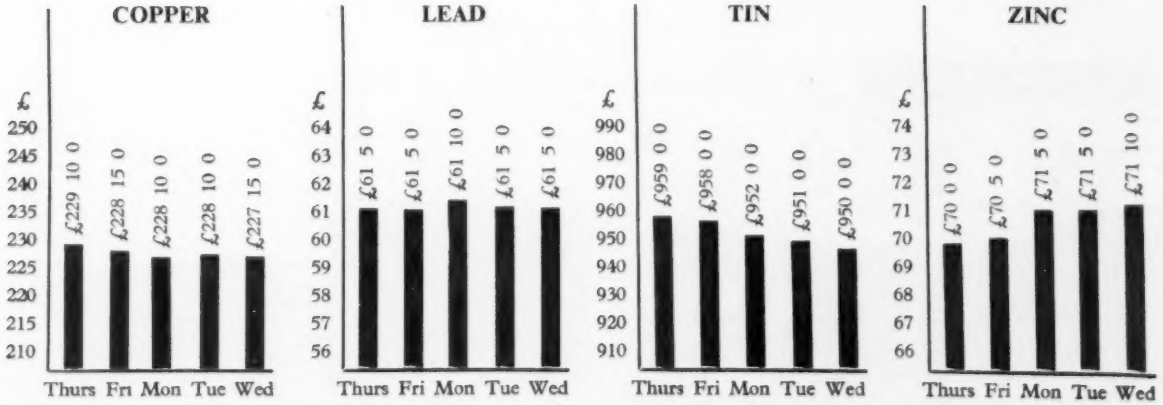

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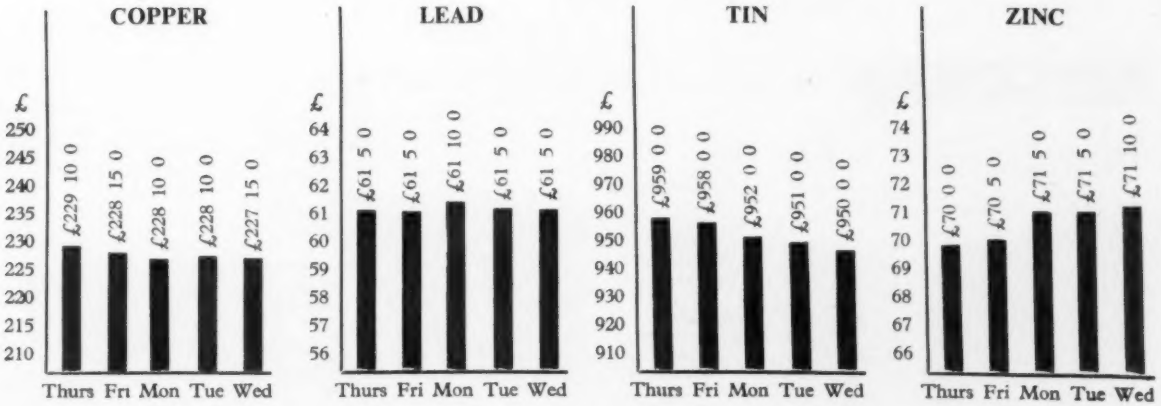

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NON-FERROUS

PRIMARY METALS

All prices quoted are those available at 2 p.m. 29/11/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	„	237	10	0
Antimony Metal 99%	„	230	0	0
Antimony Oxide Commercial	„	194	10	0
Antimony White Oxide	„	212	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	6
Calcium	„	2	0	0
Cerium 99%	„	18	0	0
Chromium	„		6	11
Cobalt	„		12	0
Columbite per unit			7	10	0
Copper H.C. Electro	ton	227	15	0
Fire Refined 99·70%	„	226	0	0
Fire Refined 99·50%	„	225	0	0

		£	s.	d.
Copper Sulphate	ton	78	0	0
Germanium	grm.		—	
Gold	oz.	12	9	8½
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	61	5	0
Magnesium Ingots	lb.			
99·8%	„		2	2½
99·9+%	„		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		5	6
Alloy Ingot. AZ91X		1	11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	59	0	0
Molybdenum	lb.	1	15	0
Nickel	ton	660	0	0
F. Shot	lb.		5	11
F. Ingot	„		5	11
Osmium	oz.	20	0	0
Osmiridium	„		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	„	30	5	0
Rhodium	„	46	0	0
Ruthenium	„	16	0	0
Selenium	lb.	2	1	0
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	8
Tellurium Sticks	lb.	2	0	0
Tin	ton	950	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	72	0	0
Dust 95/97%	„	112	0	0
Dust 98/99%	„	118	0	0
Granulated 99+%	„	97	0	0
Granulated 99·99+%	„	108	8	9

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

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Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 ton	nom.		
B.S. 1490 L.M.6 „	„		
B.S. 1490 L.M.7 „	„		
B.S. 1490 L.M.8 „	„		
B.S. 1490 L.M.9 „	„		
B.S. 1490 L.M.10 „	„		
B.S. 1490 L.M.11 „	„		
B.S. 1490 L.M.12 „	„		
B.S. 1490 L.M.13 „	„		
B.S. 1490 L.M.14 „	„		
B.S. 1490 L.M.15 „	„		
B.S. 1490 L.M.16 „	„		
B.S. 1490 L.M.18 „	„		
B.S. 1490 L.M.22 „	„		

Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	144	0	0
B.S. 1490 L.M.2	„	145	0	0
B.S. 1490 L.M.4	„	154	0	0
B.S. 1490 L.M.6	„	170	0	0
***Aluminium Bronze**				
BSS 1400 AB.1	ton	238	0	0
BSS 1400 AB.2	„	245	0	0

		£	s.	d.
***Brass**				
BSS 1400-B3 SCB2	ton	176	0	0
BSS 249	„	172	0	0
***Gunmetal**				
B.S. 1400: LG2 d/d	„	209	0	0
B.S. 1400: LG3 d/d	„	219	0	0
B.S. 1400: GI 1½ Pb d/d	„	278	0	0
B.S. 1400: GI ½ Pb d/d	„	293	0	0
***Manganese Bronze**				
BSS 1400 HTB1	„	192	0	0
BSS 1400 HTB2	„	211	0	0
BSS 1400 HTB3	„	227	0	0
Nickel Silver				
Casting Quality 12%	„	255	0	0
„ „ 16%	„	265	0	0
„ „ 18%	„	310	0	0
***Phosphor Bronze**				
B.S.1400P.B.1.(A.I.D. released)	„	312	0	0
B.S. 1400 L.P.B.1	„	234	0	0

**Average prices for the last week-end.*

Phosphor Copper	£	s.	d.
10% ton	251	0	0
15% „	254	0	0
Phosphor Tin			
5% „	1040	0	0
Silicon Bronze			
BSS 1400-SB1 „	275	0	0
Solder, soft, BSS 219			
Grade C Tinmans „	425	5	0
Grade D Plumbers „	336	5	0
Grade M „	469	10	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „		—	
Zinc Alloys			
BSS 1004 Alloy A ton	101	18	9
BSS 1004 Alloy B „	105	18	9
Sodium-Zinc lb.		2	6

SCRAP METALS

Merchants' average buying prices delivered, per ton, 28/11/61

Aluminium	£
New Cuttings	134
Old Rolled	97
Segregated Turnings	72
Brass	
Cuttings	154
Rod Ends	141
Heavy Yellow	131
Light	126
Rolled	142
Collected Scrap	128
Turnings	134

Copper	£
Wire	205
Firebox, cut up	203
Heavy	197
Light	192
Cuttings	208
Turnings	194
Braziery	162
Gunmetal	£
Gear Wheels	196
Admiralty	196
Commercial	175
Turnings	170

Lead	£
Scrap	49
Nickel	
Cuttings	—
Anodes	590
Phosphor Bronze	
Scrap	175
Turnings	170
Zinc	
Remelted	62
Cuttings	47
Old Zinc	30

METAL PRICES

SEMI-FABRICATED PRODUCTS

Prices vary according to dimensions and quantities. The following are the basic prices for certain specific products

		£	s.	d.
Aluminium				
Sheet 10 S.W.G.	lb.		2	10½
Sheet 18 S.W.G.	,,		3	0½
Sheet 24 S.W.G.	,,		3	3½
Strip 10 S.W.G.	,,		2	10½
Strip 18 S.W.G.	,,		2	11½
Strip 24 S.W.G.	,,		3	1
Circles 22 S.W.G.	,,		3	4½
Circles 18 S.W.G.	,,		3	3½
Circles 12 S.W.G.	,,		3	2½
Plate as rolled	,,		2	10
Sections	,,		3	4
Wire 10 S.W.G.	,,		3	1½
Tubes 1 in. o.d. 16 S.W.G.	,,		4	4
Aluminium Alloys				
BS 1470. HS19W.				
Sheet 10 S.W.G.	,,		3	3
Sheet 18 S.W.G.	,,		3	5½
Sheet 24 S.W.G.	,,		4	1
Strip 10 S.W.G.	,,		3	3
Strip 18 S.W.G.	,,		3	4½
Strip 24 S.W.G.	,,		4	0½
BS1477. HP30M.				
Plate as rolled	,,		3	1
BS1470. HC15WP.				
Sheet 10 S.W.G.	,,		4	3
Sheet 18 S.W.G.	,,		4	8½
Sheet 24 S.W.G.	,,		5	8½
Strip 10 S.W.G.	,,		4	4
Strip 18 S.W.G.	,,		4	8½
Strip 24 S.W.G.	,,		5	4½

		£	s.	d.
Aluminium Alloys—cont.				
BS1477. HPC15WP. Plate heat treated	lb.		3	10½
BS1475. HG19W. Wire 10 S.W.G.	,,		4	2
BS1471. HT19WP. Tubes 1 in. o.d. 16 S.W.G.	,,		5	5
BS1476. HE19WP. Sections	,,		3	4
Split tube				
19 S.W.G. (¼″)	,,		4	2
20 S.W.G. (⅜″)	,,		3	11
21 S.W.G. (⅜″)	,,		4	1
22 S.W.G. (¼″)	,,		4	11
Welded tube 14 to 20 S.W.G. (sizes ½″ to 1½″)	,,	3/5½ to 5/5		
Brass				
Tubes	lb.		1	9¾
Brazed Tubes	,,		3	1¾
Drawn Strip Sections	,,		3	1¾
Sheet	ton	195	10	0
Strip	,,	195	10	0
Extruded Bar	lb.		1	11¾
Condenser Plate (Yellow Metal)	ton	184	0	0
Condenser Plate (Naval Brass)	,,	198	0	0
Wire	lb.		2	8½

		£	s.	d.
Beryllium Copper				
Strip	lb.	1	4	11
Rod	,,	1	1	6
Wire	,,	1	4	9
Copper				
Tubes	lb.		2	3⅛
Sheet	ton	262	10	0
Strip	,,	262	10	0
H.C. Wire	,,	281	5	0
Cupro Nickel				
Tubes 70/30	lb.		3	8¾
Lead				
Pipes (London)	ton	98	5	0
Sheet (London)	,,	96	0	0
Tellurium Lead	,,	£6 extra		
Nickel Silver				
Sheet and Strip 10%	lb.		3	11¾
Wire 10%	,,		4	4¾
Phosphor Bronze				
Wire	,,		4	2
Titanium (1,000 lb. lots)				
Billet 4½″ to 18″ dia.	lb.	47/-		48/-
Rod ¼″ to 4″ dia.	,,	85/-		53/-
Wire ·036″·232″ dia.	,,	159/-		99/-
Strip ·001″ to ·048″	,,	350/-		68/-
Sheet 8′×2′. 20 gauge	,,	73/-		
Tube, representative average gauge	,,	198/-		
Extrusions	,,	90/-		
Zinc				
Sheet	ton	106	5	0
Strip	,,	nom.		

FOREIGN QUOTATIONS

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

Belgium	fr/kg	£/ton
Copper: electrolytic	31.75	232 1
Tin	134.20	980 17

Canada	c/lb	£/ton
Aluminium	24.00	194 8
Copper: electrolytic	30.00	243 0
Lead	10.00	81 0
Nickel	82.50	668 5
Zinc: Prime western	11.50	93 3
High grade 99.95	12.10	98 0
High grade 99.99	12.50	101 5

France	fr/kg	£/ton
Aluminium	2.43	179 11
Antimony 99·0	2.80	206 18
Cadmium	16.75	1,247 16
Copper: electrolytic	3.21	237 4
Lead	.90	66 10
Nickel	9.00	665 2
Tin	13.70	1,012 8
Zinc: Thermic	1.07	79 1
Zinc: electrolytic	1.15	85 0
Scrap		
Copper: electrolytic	2.85	210 12
Heavy copper	2.85	210 12
No. 1 copper wire	2.78	205 8
Brass rod ends	2.17	160 7
Zinc castings	.85	62 16
Lead	.82	60 11
Aluminium	1.80	133 0

Italy	lire/kg	£/ton
Aluminium	370	216 1
Antimony 99·0	470	274 9
Copper: wire bars 99·9	445	259 17
Lead	155	90 10
Nickel	1,300	805 14
Tin	1,840	1,074 11
Zinc: electrolytic	165	96 7
Scrap		
Aluminium soft sheet clippings (new)	290	169 7
Lead, soft, first quality	130	75 18
Lead, battery plates	74	43 4
Copper, first grade	370	216 1
Bronze, commercial gunmetal	420	245 7
Brass: heavy	270	157 13
Brass: light	255	148 18
Brass, bar turnings	265	154 15
Old zinc	93	54 6

Switzerland	fr/kg	£/ton
Aluminium	2.50	210 5
Copper: electrolytic	2.88	242 4
Lead	.80	67 5
Nickel	7.68	645 17
Tin	11.68	982 5
Zinc: High grade 99.99	.98	82 8

Japan	Yen per metric ton
Scrap	
Copper: electrolytic	268,000
Copper wire No. 1	240,000
Copper wire No. 2	225,000
Heavy copper	233,000
Light copper	213,000
Brass, new cuttings	175,000
Red brass scrap	215,000

West Germany *Scrap*	D-marks per 100 kilos	£/ton
Used copper wire	220	200 8
Heavy copper	220	200 8
Light copper	185	168 10
Heavy brass	150	136 13
Light brass	110	100 5
Soft lead	50	45 11
Zinc	48	43 14
Used aluminium unsorted	90	82 0

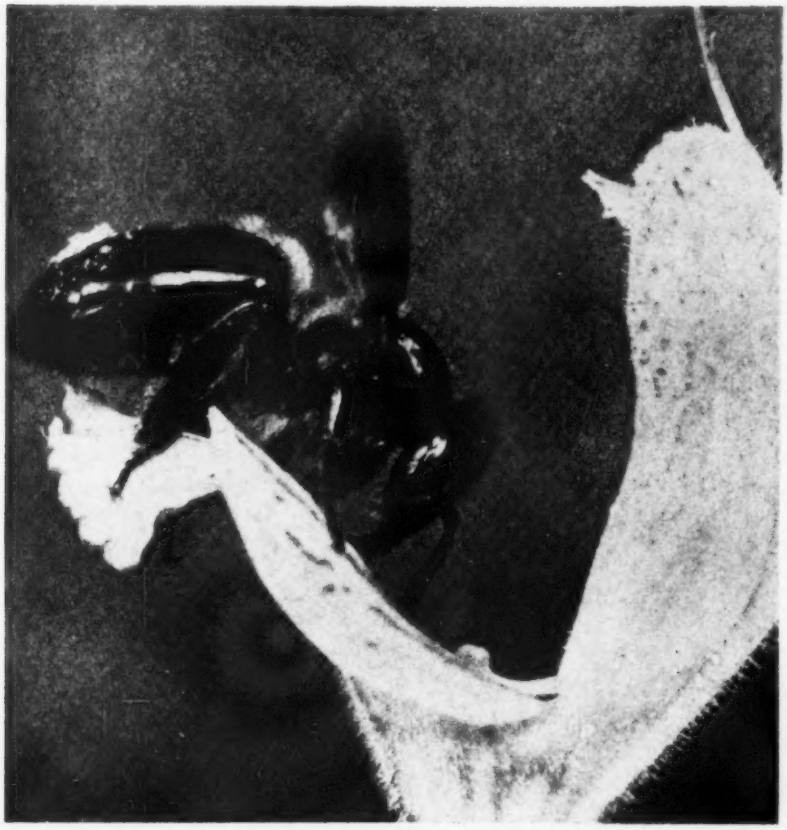
United States	c/lb	£/ton
Aluminium	24.00	1591
Antimony 99·0	32.50	259 0
Cadmium	160.00	1,275 4
Copper: electrolytic	31.00	247 10
Lead	10.00	79 14
Nickel	82.34	656 4
Tin	123.00	980 6
Zinc: electrolytic	12.50	99 12

THE STOCK EXCHANGE

Investors Holding Back

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 27 NOVEMBER	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	29/9	—3d.	11	9	7 8 0	33/9	26/3	35/–	26/6
400,000	2/–	Anti-Attrition Metal	1/3		NIL	4	NIL	1/3½	0/9	1/6	0/9
43,133,663	Stk. (£1)	Associated Electrical Industries ...	31/3	—2/9	15	15	9 12 0	54/10½	28/3	67/3	38/3
3,895,963	1	Birfield	61/3	—2/6	10	15‡	3 5 3	78/9	45/–	51/3	29/–
4,795,000	1	Birmid Industries	64/6	—9d.	20	20	6 4 0	103/–	64/6	74/9	56/–
8,445,516	Stk. (10/–)	Birmingham Small Arms	18/9	—2/9	11½	11½K	6 4 6	36/10½	13/10½	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	13/–		5	5	7 13 9	14/6	12/3	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/6		6	6	7 5 6	17/6	15/4½	20/–	17/1½
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	16/–	—1/–	6	6	7 10 0	18/–	15/3	21/1½	17/7½
21,737,634	Stk. (£1)	British Insulated Callender's Cables	56/3	—2/6	13½	13½	4 16 0	62/3	49/–	61/4½	47/–
30,683,348	5/–	British Oxygen Co. Ltd., Ord. ...	14/3	—9d.	16D	16	3 14 9	28/4½	14/6	35/–	19/10½
1,200 000	Stk (5/–)	Canning (W.) & Co.	16/–	—6d.	15½	25 + *2½C‡	5 0 0	20/9	13/7½	19/9	13/7½
60,484	1/–	Carr (Chas.)	1/1½		NIL	NIL	—	1/7½	10½d.	2/3	1/–
550 000	1	Clifford (Chas.) Ltd.	27/6	—3d.	12	10	8 14 9	31/–	26/–	35/–	28/9
45,000	1	Ditto Cum. Pref. 6%	15/–		6	6	8 0 0	15/3	15/–	16/–	15/10½
1,166,000	Stk. (2/–)	Clifford Components V	8/–	—6d.	25*2½C	25*2½C	6 5 0	10/1½	7/3	11/9	6/10½
300,000	2/–	Coley Metals	2/9		15	15	10 18 3	4/5½	2/7½	5/–	3/4½
10,185,696	1	Cons. Zinc Corp.†	48/6	—1/6	20 O	15	8 5 0P	81/6	48/–	80/9	59/6
5,399,056	5/–	Davy-Ashmore	30/6	—6d.	27½	22½	4 10 3	44/6	29/–	147/3	99/6
8,995,011	5/–	Delta Metal	20/6	—9d.	20	17½	4 17 6	27/7½	19/–	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	35/3xd	—1/10½	15	15	8 10 3	52/3	35/6	56/9	45/–
1,155,000	1	Evered & Co.	42/–		10	10◊B	4 15 3	45/9	42/–	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	26/–	—2/3	10	10	7 13 9	39/6	24/3	47/9	29/–
1,500,000	Stk. (10/–)	General Refractories Ltd.	47/3	—1/–	25	20	5 5 9	65/–	42/9	52/6	40/–
937,500	5/–	Glacier Metal Co. Ltd.	19/6	+6d.	15	13	3 17 0	21/1½	13/9	16/1½	11/1½
2,750,000	5/–	Glynwed Tubes	23/6	—6d.	22½	25¶	4 15 9	30/3	22/6	27/6	17/–
7,228,065	10/–	Goodlass Wall & Lead Industries ...	31/6	—3d.	15	19L	4 15 3	44/9	28/–	41/9	33/–
696,780	10/–	Greenwood & Batley	16/–	+1/6	15	30‡	9 7 6	29/6	14/3	33/6	29/1½
792 000	5/–	Harrison (B'ham) Ord.	8/9		*10	*20‡	5 4 3	14/6	8/6	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	18/3		7	7	7 13 6	20/4½	18/–	23/6	22/–
1,612,750	5/–	Heenan Group	13/9		13	11½K	4 14 6	17/1½	10/6	13/–	9/10½
266,608,683	Stk. (£1)	Imperial Chemical Industries ...	60/–	—1/9	13½	11½	4 11 9	81/6	56/3	76/6	54/–
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	14/3	—4½d.	5	5	7 0 3	16/–	13/10½	18/–	15/4½
29,196,118	**	International Nickel	135	—4	$1.60	$1.50	2 0 0	160	104	105	84½
6,000,000	1	Johnson, Matthey & Co.	80/–	+2/6	15	12	3 15 0	80/3	57/6	67/6	44/9
600,000	10/–	Keith, Blackman	17/–		17½	17½E	10 6 0	21/6	16/6	32/6	17/6
320,000	4/–	London Aluminium	12/9	+2/6	N	13	—	15/–	8/6	12/6	7/10½
2,667,542	1	McKechnie Bros. A Ord.	32/–		11½K	17½	7 8 0	53/3	31/3	69/3	55/–
1,108,268	5/–	Manganese Bronze & Brass	9/6		20½	20½	10 10 0	18/6	8/3	18/6	13/4½
50,628	6/–	Ditto (7½% N.C. Pref.)	5/–		7½	7½	9 0 0	6/–	5/–	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	81/6	—4/6	12	12M	2 18 9	100/9	68/3	84/3	61/–
415,760	Stk. (2/–)	Metal Traders	5/–	—6d.	25	50H	10 0 0	8/9	5/–	10/9	7/1½
240,000	1	Mint (The) Birmingham	36/6	+1/–	15G	12½	5 9 6	36/6	24/–	39/–	33/6
80,000	5	Ditto Pref. 6%	70/–	—1/–	6	6	8 11 6	77/6	70/–	80/–	75/–
274,152	1/–	Minworth Metals	4/9		30	30S	6 6 3	6/3	4/6½	5/2½	1/10½
5,187,938	Stk. (£1)	Morgan Crucible A	59/3	—6d.	14	13	4 14 6	71/3	53/4½	63/–	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	15/6		5½	5½	7 2 0	17/–	13/10½	18/9	15/9
3,850,000	Stk. (£1)	Murex	39/6	—1/–	13	22½J	6 11 9	52/–	36/9	45/–	35/3
585,000	5/–	Ratcliffs (Great Bridge) Ord. ...	15/6		10	10R	3 4 6	16/6	15/6	17/–	14/9
1,064,880	10/–	Sanderson Kayser	34/6	—6d.	17½	35‡	5 1 3	41/3	29/–	40/3	27/7½
3,400,500	Stk. (5/–)	Serck	12/3	—9d.	12½	12½	5 2 0	19/3	12/2½	25/6	15/3
212,384	5/–	Stedall & Co.	7/6		15	15	10 0 0	10/3	7/3	10/3	6/3
8,035,372	Stk. (£1)	Stone-Platt Industries	38/9	+9d.	16 O	15	8 5 3W	67/–	37/9	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/–		5½	5½	7 6 9	18/–	13/6	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	62/–	—3/–	14	18½	4 10 3	85/6	54/–	140/3	63/10½
41,000,000	Stk. (£1)	Vickers	25/9	—1/3	10	10	7 15 3	38/3	25/6	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref. 5%	13/6		5	5	7 8 3	15/–	12/4½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	19/9		*5	*5	7 10 9A	21/1½	18/–	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	64/6	—1/–	13½	13½	4 2 3	84/6	64/6	94/–	63/–
7,109,424	Stk. (£1)	Westinghouse Brake	24/9	—1/3	11	10	8 17 9	46/3	24/6	60/6	37/6
323,773	2/–	Wolverhampton Die-Casting ...	6/3xd	—1/–	30	35	9 12 0	13/4½	6/–	13/10½	8/1½
591,000	5/–	Wolverhampton Metal	21/9		32½	32½	7 9 6	30/–	19/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/6	+1½d.	15	20‡	8 6 9	4/9	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	12/9		6	6	9 8 3	13/7½	12/6½	15/–	13/6
150.000	1/–	Zinc Alloy Rust Proof	4/3	—3d.	40	30	9 8 3	5/6	4/–	5/4½	4/–

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡and 100% capitalized issue. ● The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. B and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. R and 33⅓% capitalized issue in 8% Maximum Ordinary 5/– Stock Units. ◊ and 6¼% from Capital Profits. B and 50% capitalized issue. G and 50% capitalized issue. F and special 5% tax free dividend and 50% capitalized issue. ¶and 3 for 7 capitalized issue. L and 33⅓% capitalized issue. M and 10% capitalized issue. J and 75% capitalized issue. Q also 1/– special tax free dividend and 50% capitalized issue. T Per £1 unit. K 50% capitalized Issue allowed for. S and 50% capitalized issue. V incorporating Clifford Covering. H including bonus 12½%. N current interim dividend passed. O current interim reduced. P calc. at 20%. W calc. at 16%.



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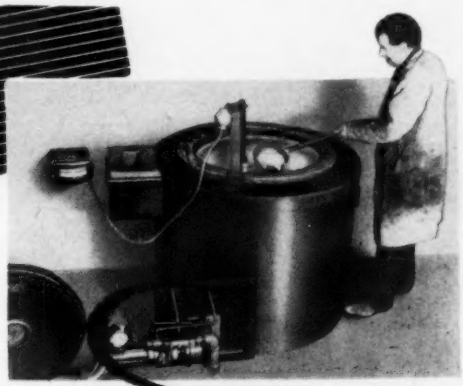

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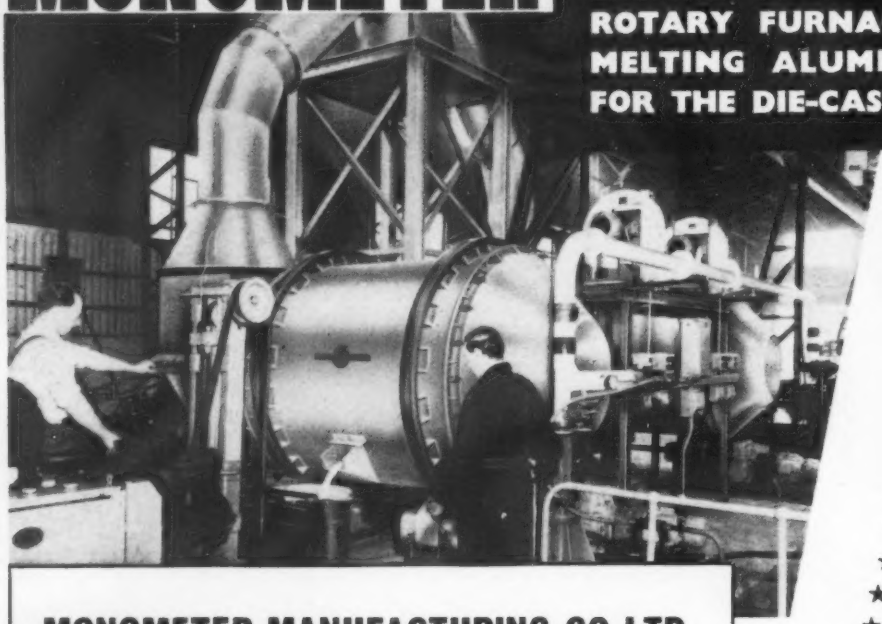

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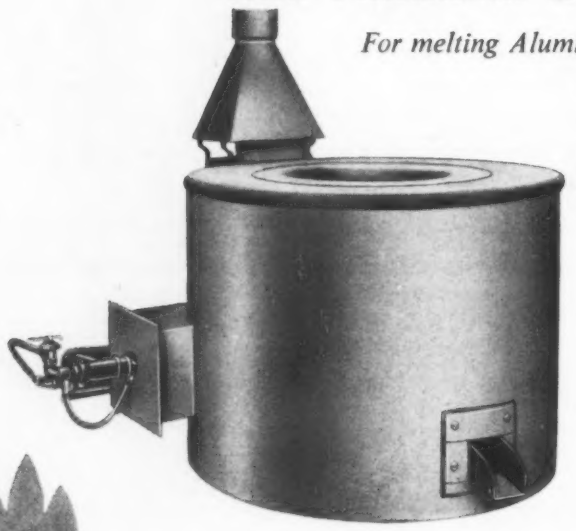

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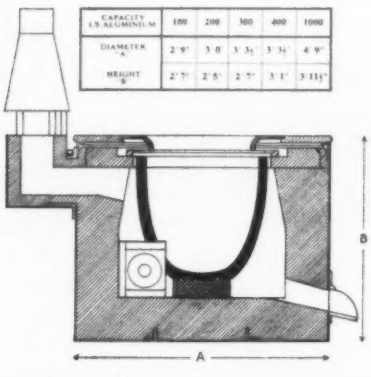

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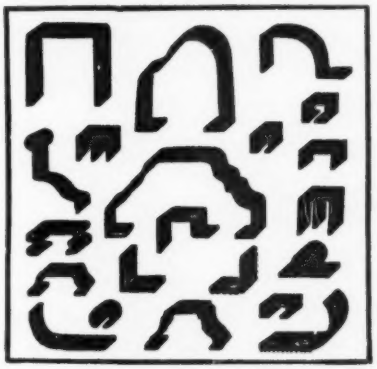

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